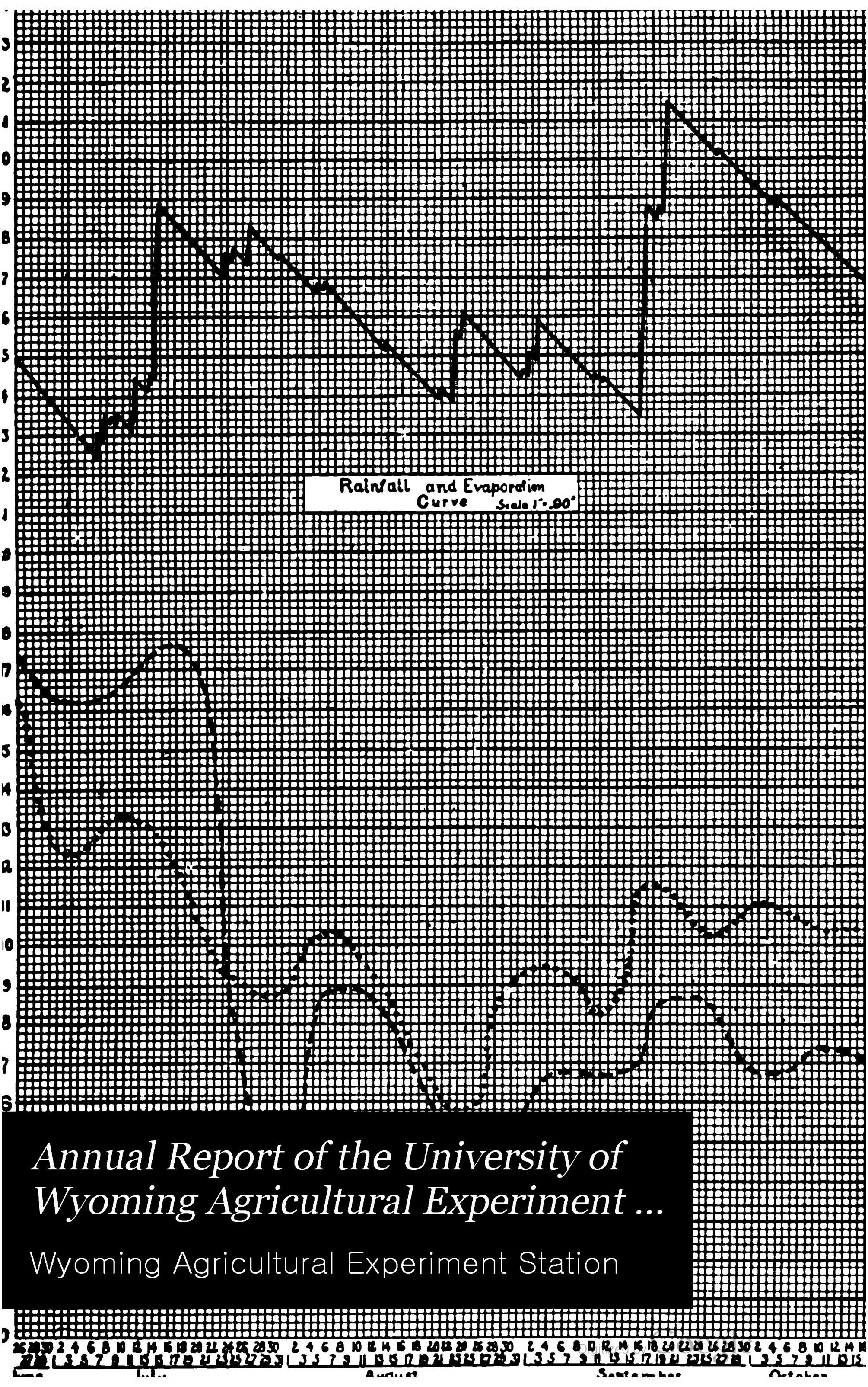

Annual Report of the University of Wyoming Agricultural Experiment ...

Wyoming Agricultural Experiment Station

The University of Wyoming

Agricultural College Department

ELEVENTH ANNUAL REPORT

. . . OF THE . . .

U. S. Agricultural Experiment Station

. . . OF . . .

WYOMING

1900-1901

LARAMIE, WYOMING,
U. S. A.

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LARAMIE, WYOMING,
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Letter of Transmittal.

U. S. Agricultural Experiment Station,
University of Wyoming.

To His Excellency, DeForest Richards, Governor of Wyoming:

Sir:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating agricultural experiment stations, I have the honor herewith to submit the Twelfth Annual Report of the U. S. Agricultural Experiment Station of Wyoming.

Director.

University of Wyoming,
June 30, 1902.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

Agricultural Committee of the Board of Trustees.

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BURTON P. FLEMING, B. S	Irrigation Engineer
ELIAS E. NELSON, A. M	Assistant Horticulturist
E. E. SIGMAN	Foreman Experiment Farm

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Report of Station Council.

Report of the Director.

ORIGIN AND PURPOSE OF THE STATION.—The U. S. Agricultural Experiment Station in Wyoming is the department of research of the College of Agriculture of the University of Wyoming. Congress in 1887 appropriated $15,000 annually for this purpose, and on January 10, 1891, the Wyoming legislature authorized the University of Wyoming to receive this appropriation. The work of the station is to aid in the acquiring and diffusing among the people of the United States, and especially of Wyoming, useful and practical information on subjects connected with agriculture, to conduct scientific investigations and experiments on the physiology of plants and animals; to investigate animal and vegetable diseases and parasites; to chemically analyze soils and water and vegetable and animal products; to acclimate grains and grasses, fruits and vegetables, to our arid climate and high altitude; to ascertain the best methods of irrigation, and of retaining the moisture in the soil; to find the best breeds of stock, and the best varieties of field and garden crops for the various portions of Wyoming; and to carry on any other experiments which promise to benefit our agricultural and grazing interests. The results of these experiments are published in the station bulletins, which are sent free upon request to residents of this state.

THE STATION COUNCIL—WHAT IT IS.—Besides their regular work in the class room, our professors of agriculture, botany, chemistry, physics and geology are also members of the staff on our Station Council and are engaged along their several lines of investigation in connection with the experiment

staff on our Station Council and are engaged along their several lines of investigation in connection with the experiment work of this government station. These five professors of natural science, together with the president of the university, who is director of the station, and the secretary of the board of trustees, who is the secretary of the station, form the Station Council. This body passes on all matters pertaining to station work in the way of experimentation and research, and its recommendations are then referred to the agricultural executive committee of the board of trustees.

All plans of work by the heads of departments are first discussed and accepted, modified or rejected by the Station Council; this system insures the co-operation of the staff of station workers and prevents scattered work and misapplied effort. Again, all bulletins published by the station are first read before the Station Council and each member is free to criticise any questionable point of fact, extravagant statement or the general arrangement of the matter; and finally the bulletin may be either adopted and recommended to the agricultural executive committee of the board of trustees for publication, or it may be returned for revision, or be entirely rejected. Such has been the general policy governing the station since its organization; and the fact that the workers have been a unit force, and so have made a combined attack on the important agricultural problems from all sides at the same time, has contributed largely to their success heretofore.

WHAT IT DOES.—The study and research of the station are made as practical as possible, and have to do with the problems which in our opinion are of most importance to the farmers of the state. For example, the subject of irrigation and the alkali problem have been given much attention. At the present time, so far as we can we are co-operating with the Department of Agriculture at Washington in the new irrigation work being done under the direction of Mr. Elwood Mead, who has

Stations. The results of our work are being published from time to time. The carefully prepared bulletins, based as they are upon as thorough work as we can do, are offered to the people with the belief that they contain nothing but reliable information, upon which the greatest dependence may be placed.

The widely scattered population of the state has made it almost impossible for the station to come into direct contact with our farmers. The farming communities are naturally located in the places most favorable to agriculture, and are sometimes separated from one another by mountain ranges and long distances; and with the funds at our command and the small number of our station workers it has so far seemed impracticable to do any general farmers' institute work. However, when the time comes that it is possible for us to engage in this kind of work, we shall be glad to undertake it; because we believe it will prove most valuable in bringing the farmers and our station into closer relation with each other. The station workers would then become better acquainted with the farmers' needs, and the information offered by the station could be better brought before the attention of the farmers.

THE FARM AND BUILDINGS.—The station buildings are a small five room cottage, a tool shed, and a shed used as a barn at the farm; and a barn and green-house on the university grounds. The farm is well equipped with implements and all needed machinery. The great need of the station is a good-sized barn in which to store farm implements and grain, and to provide room for threshing and winnowing of seeds indoors.

With only the amount which can be used each year for building purposes from the Hatch fund ($750) it is not possible to build more than in a very small way, and it would seem that the state will need to make some provision in the near future for more commodius buildings for the station. Particularly is this true, in case any work is begun in animal industry; it will then be necessary to add to the buildings at considerable cost.

this true, in case any work is begun in animal industry; it will then be necessary to add to the buildings at considerable cost. The time has come when it would seem to be necessary for us to begin to take some steps in this direction, in order to meet the demands of the stockmen in this stock-growing state. And here the Director would beg to offer the following suggestion:

When the vote of the last legislature shall have been carried into effect and the present buildings in Laramie now occupied as a penitentiary shall have been abandoned for the new state building at Rawlins, will it not be practicing a wise economy for the next legislature to turn over the old grounds and buildings in Laramie to the State Agricultural College of the University of Wyoming? And by so doing, would not the state show its good faith in receiving the generous donation from the federal government through the Hatch fund?

BULLETINS.—Four bulletins have been published by this station during the fiscal year 1901-1902. The bulletins are:

NUMBER 50. NATIVE VINES IN WYOMING HOMES.

This illustrated bulletin is calculated to foster the growth of native hardy shrubbery around the home.

With all the wide expanse of almost treeless plains and the so-called deserts there is a considerable number of flowering and other shrubs which, with a little care, can be brought round the ranch, or city homes, to adorn the grounds and help protect them from the hot sun in summer and cold winds in winter. They also help to cultivate a taste for the beautiful. Every one who sees a fine shrubbery and well-kept grounds may have some pleasure from the sight but not so much as he who plants and cares for the inanimate plants there gathered.

This bulletin contains nine full page cuts and fourteen pages of text. It is enough out of the common line of Station bulletins to arrest attention and arouse a train of thought in another line of considerable importance to the majority of our people.

NUMBER 51. I. SHEEP FEEDING ON THE RANGE. II. LAMB FEEDING—SECOND TRIAL.

The sheep feeding experiment was made by co-operation with the gentlemen, Cosgriff Bros., Fort Steele, Wyoming. Hon. Thos. A. Cosgriff gave considerable of his personal attention to securing the data from a band of sheep he was feeding for market. For several years this firm has fed sheep on the range and realizes prices far above those for which cull range sheep are usually sold.

The main features of the experiment were: On October 14, 1901, 2,843 old ewes and 500 two-year-old wethers were put on feed. Sold to local butchers, 47. Sold in Omaha Dec. 26, 1901, 1,820 of these sheep. Shipped the remainder, 1,415, of these sheep to Chicago, Jan. 22nd, 1902. Shrinkage 61. Loss of weight in shipping from Walcott, Wyo., to Chicago approximately 6½ per cent.

Feeds were very high during the past season as shown in the following:

3,235 sheep sold for	$10051.59	
47 sheep sold to local butchers for	141.00	$10,192.59
Corn purchased, 295,894 lbs. at $1.39 cwt	4112.93	
Oats purchased, 46,682 lbs. at $1.52 cwt.	755.16	
Expended for labor	315.00	
Hay for horses, etc	30.00	5,213.09
Net receipt for 3,343 sheep		$ 4,979.50

This amounts to $1.49 per head on the range.

Such a result shows what may be gained by feeding sheep on the range when most sheep men sell cull sheep at not far from one dollar per head on an average.

LAMB FEEDING—SECOND TRIAL.

(Alfalfa vs. Native Hay For Lambs.)

This was a repetition of the lamb feeding of the previous winter. One hundred merino lambs were fed in two lots of

50 each. This experiment was interrupted by a snow and wind storm during the first month. The lambs were necessarily run together again for a while and were then separated and the experiment continued 70 days. Up to this time there had been a profitable gain of weight. The lambs were sold to be taken as needed by the local butchers and feeding continued for 55 days. During this last period there was a good substantial gain in weight but the feed cost more than the gained flesh was worth.

One hundred and four lambs were purchased and three died of bloat from eating snow and alfalfa and another during the last period from the native hay lot.

	Native Hay		*Alfalfa*	
	Dr.	Cr.	Dr.	Cr.
Original cost	$ 78.00		$ 78.00	
Cost to feed, preliminary period, 33 days.......	25.47		25.47	
Cost to feed, comparative period, 70 days.......	62.80		77.48	
	166.27		180.95	
Value at end of comparative period				
Lot 1, 3,227 lbs. at $5.25 per cwt.		$169.42		
Lot 2, 3,695 lbs at $5.25 per cwt.				$193.99
To balance, net gain.	3.15		13.04	
	$169.42	$169.42	$193.99	$193.99

CONCLUSIONS.

The experiment last year showed on the whole a small loss. This year up to the conclusion of the comparative feeding of alfalfa and native hay there was a profit, the high price for feed being balanced by a high price for the lambs. But on the closing period, although the lambs continued to make good substantial gains, there was a heavy loss, aggregating nearly

three times the profit up to the end of the comparative period.

Total cost per head for the whole time of experiment was $4.23.

Total receipts were $4.025.

Cost per head for corn was $1.62.

Value of hay at farm as fed, after paying for corn, alfalfa and native hay, taken together at one price, $9.43 per ton.

Value of native hay, comparative period, $12.50 per ton.

Value of alfalfa hay, comparative period, $16.66 per ton.

The value of alfalfa hay for the whole experiment was $8.88, after corn and native hay had been paid for at $30 and $11 per ton—the market prices in Laramie.

These deductions are made without taking the risk, value of labor, or interest into consideration. Feeders can make their own charges under these heads in calculations on feeding.

NUMBER 52. EXPERIMENTS IN EVAPORATION

1. How rapidly does moisture evaporate from the soil when the level of water is kept at a certain distance from the surface by subirrigation?

2. What effect has stirring the soil once a week to certain depths upon the evaporation of moisture when the level of water is maintained at a constant depth?

3. What effect has sub-irrigation upon the rise of alkali?

4. What effect has alkali upon the evaporation of moisture when the level of water is kept at a certain depth from the surface?

The following conclusions were drawn from these experiments:

The evaporation from the surface of the soil with the level of water maintained at 6 inches below was 95 per cent, at 12 inches below it was 70 per cent, at 18 inches below it was 45 per cent, and at 22 inches below it was 35 per cent of what it was at the surface of the water in the evaporation tank.

Stirring the ground once a week to the depth of 2 inches retarded evaporation to the amount of 19 per cent, when stirred to a depth of 4 inches it was retarded 23 per cent, and when stirred to a depth of 6 inches evaporation was retarded 45 per cent. The water in all three of the pipes was maintained at a depth of 22 inches below the surface of the soil.

Evaporation was retarded 43 per cent when the soil contained .0597 per cent of alkali and the level of water was maintained at 6 inches below the surface. The amount of retardation was 55 per cent in soil containing .5116 per cent of alkali, and the level of water 12 inches below the surface. In soil containing .5375 per cent of alkali the amount of retardation was 50 per cent when the level of water was maintained at 18 inches below the surface; while the retardation was 57 per cent in soil containing .6205 per cent of alkali and the level of water kept at 22 inches below the surface. The amount of alkali is the average amount found in the entire 26 inches of soil.

More alkali was found in the first three inches than in any other three inches of the soil.

More alkali was found in the last two inches than in the three next above.

NUMBER 53. THE MEASUREMENT OF WATER FOR IRRIGATION:

This bulletin is the result of an effort to induce and help Wyoming irrigators to govern their use of water by their lawful right and to aid watermasters toward more system and accuracy in the distribution of the water supply.

To this end in the first part of the bulletin are explained the principles of water measurement together with the use and installation of the weir and rating flume and methods of measuring streams by direct observation. Weir tables are included computed for widths of weir varying from one to ten feet and with heads varying from zero to twenty inches by every eighth of an inch.

In the second part of the bulletin the particular provisions of the Wyoming law relating to the appropriation and distribution of water are given with a view to more widely diffusing knowledge on the subject and thus aiding in some measure perhaps toward a more general compliance with the spirit of the law.

In addition to these four bulletins the following press bulletins have been issued. This list includes one—No. 11—which was written in July.

NUMBER 1. FEEDING VALUE OF WHEAT.

At the present time it seems in place to call attention to the feeding value of wheat because of its comparatively low price and the scarcity of corn. Wheat will, at least, come in close competition with corn in different portions of Wyoming during the coming winter, if it does not supersede it.

The experiments of different Stations as well as my own experience show that when properly fed, it gives results with all kinds of stock practically equal to those produced by corn. In both composition and digestibility it is superior to corn, but it differs from corn in the fact that when fed alone, stock will not eat it as well and do not seem to have the same relish for it, because it is too sticky when ground, adhering to the teeth and gums. There is greater danger, too, of over-feeding than with corn, but when fed in connection with other grains, or particularly with bran, there is little danger of getting the animals off-feed and all kinds of stock then seem to like it fully as well as corn and make equally as good gains on it. In my own experience, I have usually mixed it with bran, half and half by weight, and have secured excellent results.

In experiments conducted by the writer at the Utah Experiment Station, wheat, pound for pound, proved superior to corn when fed to growing animals. Fed to thrifty young pigs, twelve to fifteen pounds of pork were secured from each bushel

—(2)

of wheat. Taking the average of the several experiments conducted with hogs of different ages and in various conditions, it required 424 pounds of wheat meal as compared with 418 pounds of corn meal for 100 pounds gain. Five hundred and four pounds of wheat meal and bran, mixed half and half, made the same gain. It was found best to grind the wheat coarse and then wet it with water at the time of feeding, rather than soak the whole grain, to insure complete digestion. When not convenient to grind it, soaking is beneficial, but pigs do not seem to digest it as well nor make as good use of it. Feeding wheat in the sheaf as practiced by some is not economical, except to breeding stock when on a light ration.

In cattle feeding, the Ohio Station found that corn meal and wheat meal are practically of equal value, the former excelling in one trial and the latter in another. It also found that it required 670 pounds of wheat and bran, mixed half and half, to produce 100 pounds gain. At the Kansas Station, the results with wheat alone were somewhat better than the mixture, 572 pounds making 100 pounds gain.

At the Utah Experiment Station the grain ration for a number of years for all classes of stock, including farm teams and driving horses, has consisted of ground wheat and bran mixed in the proportion of one pound of wheat to one of bran by weight. This has been fed in connection with alfalfa hay and the results have been very satisfactory.

When fed to sheep, the Michigan Station found that it required 553 pounds of wheat for 100 pounds of gain. At the Utah Station, fed to lambs, it took 451 pounds of good milling wheat, as compared with 419 of frosted wheat, for 100 pounds of gain. Both were fed whole and dry in connection with alfalfa hay.

In Manitoba, large quantities of frosted wheat are used annually for feeding purposes. Canada experiments show that when fed to swine it requires from 388 to 524 pounds to make 100 pounds of gain, depending on the age and condition of the

hogs to which it was fed. When fed to two-year-old steers in connection with corn ensilage, 343 pounds were required for each 100 pounds of gain as compared with 309 pounds of mixed meal, consisting of oil cake, barley and peas, equal parts, fed in the same way.

The following table shows the number of pounds of digestible nutrients in 100 pounds of both corn and wheat:

	Protein	Carbo-hydrates	Fat
	lbs.	*lbs.*	*lbs.*
Wheat	10.2	69.2	1.7
Corn	7.8	66.7	4.3

The superiority of wheat over corn for young stock evidently lies in the extra amount of digestible protein which it contains. As seen above, each 100 pounds of wheat contains 10.2 pounds of digestible protein while the same quantity of corn has only 7.8 pounds. This shows the wheat to contain 30 per cent or almost one-third more protein than the corn. The wheat also excels the corn by 2.5 pounds per 100 in the digestible carbohydrates (starches and sugars) it contains. The excellence of corn for fattening comes from its extra per cent of oil and also from the larger proportion of carbohydrates and fats to the protein as compared with wheat, the corn having about 10 pounds of these two ingredients to each pound of protein, while the wheat has only 7.

The Maine Station obtained better results from feeding ground wheat to dairy cows than from corn meal. Both were fed in connection with timothy hay. I am convinced from a number of years' experience in feeding wheat to cows at the Utah Station that it is fully equal to corn, if not superior for that purpose. It was there fed mixed with bran, half and half, in connection with alfalfa or corn fodder. On account of its high per cent of protein it is better than corn to feed with any roughage like timothy or native hay, which is known to be deficient in this nutrient. Another point in its favor is, that it is slightly more digestible than corn, there being 2.3 more pounds digestible in 100 than in corn.

Briefly stated, wheat excels corn in its digestibility and in the amount of protein, starches and sugars which it contains and on this account it has a higher food value.

For young animals, where growth is a consideration of as much or more importance than fattening, wheat is the better food, but for mature stock where fattening is the chief object corn is better.

Wheat has been shown by experiment to be equally as good as corn for feeding some classes of stock and, by inference, it may be said to be equally good for all classes when properly used.

If fed alone the following points should be observed: Give a very small daily allowance in the beginning and increase very gradually to a full ration, taking great care not to over-feed; grind coarse for all classes of stock except sheep, to which it should be fed whole. For best results, grind and mix with bran or some one of the grains, corn, oats, or barley. Such a mixture will prove superior to any one of the grains used alone.

LUTHER FOSTER,
November, 1901. Laramie, Wyoming.

NUMBER 2. RESULTS OF LAMB FEEDING AT THE WYOMING EXPERIMENT STATION.

The facts resulting from the lamb feeding experiment at the State Station are here reported in brief. A bulletin will soon follow giving the complete details of the work and containing illustrations showing the character of the lambs fed and other matters of interest connected with the experiment.

The principle objects sought in the undertaking were to make a comparison of the feeding value of alfalfa with that of native hay and to determine the cost of feeding lambs for market under the conditions prevalent on the Laramie plains and in other parts of the state.

In December, when the experiment was authorized, good

average lambs, such as were most desirable for the work, could not be secured and it was found necessary to select the one hundred made use of from a bunch of culls.

After a week of preliminary feeding, the lambs were divided into two sets equal in number and as nearly so as possible in weight and quality. The experiment began December 28th, and continued for a period of ninety-five days, closing April 2. The two lots had a limited amount of corn and all the hay they would eat. The lambs were slaughtered and consumed in the home market. The butchers were highly pleased with the way they cut up and especially well satisfied with the demand for them. The meat was of excellent quality. The people of Laramie consider it the best mutton ever placd on sale in this market.

The following is an extract from the summary of the bulletin:

FACTS OF THE EXPERIMENT.

Food.	*Native Hay, lbs.*	*Alfalfa Hay, lbs.*
Hay eaten daily per head	1.06	1.45
Grain eaten daily per head	.80	.80
Total food consumed daily per head	1.86	2.25
Hay consumed for 100 lbs. gain	420	460
Grain consumed for 100 lbs. gain (corn and oil cake)	317	248
Gains.		
Average weight per head at the beginning of the experiment	48.2	47.1
Average weight per head at the close of the experiment	72.3	77.9
Average gain per head in 95 days	24.1	30.8
Average daily gain per head	.253	.324
Values.		
Value of food eaten per 100 lbs. gain	$4.31	$3.76
Selling price	$4.65	$4.65
Profit per 100 lbs. gain on food consumed	.34	.89

It will be seen that the lambs fed alfalfa ate the more hay, made the larger gains and returned a higher profit. In the

above calculations both kinds of hay were estimated at $6.00 per ton and corn at 90 cents per hundred pounds.

RESULTS AS A WHOLE.

During the latter half of December good lambs for feeding were worth $4.50 to $5.00 per 100 pounds on the Chicago market. At these prices the market value of the lambs at the beginning of the experiment would not have exceeded $2.00 per head. Averaging both sets, the feed eaten cost $1.13 per head. The selling price at $4.65 per hundred brought $3.38 per head, leaving the small net profit of 25 cents per head, and this after allowing $6.00 per ton for all hay fed and 90 cents per hundred for the corn. In large quantities both hay and corn could have been purchased at considerably lower prices.

Taking the results given above as a basis of calculation, a farmer, by purchasing grain and feeding lambs, may secure a return of $11.05 per ton for alfalfa hay and $10.38 per ton for native hay.

LUTHER FOSTER.

WYOMING EXPERIMENT STATION,
LARAMIE, WYO., May 18, 1901.

NUMBER 3. ALFALFA.

(*Medicago sativa*)

SOME REASONS WHY THIS FORAGE PLANT SHOULD BE LARGELY CULTIVATED IN WYOMING.

Alfalfa is easily grown wherever there is water enough for irrigation. When once well started it produces good crops for many years without reseeding. Larger crops are produced than of any of the grasses, or of any other known forage crop which can be produced as easily, or with so little labor as it requires.

No other forage plant of its quality produces so long without reseeding. Alfalfa is a member of the Medicago family in the botanical order Leguminosae. It contains in common with

beans, peas, clover, the cowpea, and other plants of this order, a larger amount of protein than plants of other families. Protein in considerable quantity is essential to animal growth since it is the basis of muscular growth and development. This may be shown by the composition of muscle and the fact that the best development of animals is made when certain definite proportions exist between the protein compounds and the carbohydrate, or starchy compounds of the foods being consumed.

Alfalfa is a very prolific crop in yield of total forage and of protein compounds, and the forage is also of high nutritive quality. Digestion experiments with domestic animals have demonstrated that the amount of nutrient compounds taken into the animal system from it is large and the proportion of protein is greater than for almost any other coarse food. Indeed, it ranks very closely with wheat brain in the digestible nutrients, as may be seen in the comparisons given below from B. 103, Kan. Ex. Sta., and other reliable sources.

Digestible Nutrients in 100 *Pounds of*:

	Water in Air-dry Sub.	Ash	Crude Protein	N-free Extract	Crude Fiber	Fat
Prairie hay	9.07	7.97	0.61	29:14	17.76	1.97
Buffalo Grass hay	8.16	.70	6.20	26.24	15.77	1.28
Alfalfa hay	8.77	6.10	13.24	26.02	13.24	0.89
Timothy hay	13.20	....	2.8	43.4		1.4
Millet hay	7.7	....	4.5	51.7		1.3
Wheat bran	11.99	....	12.2	39.2		2.7

The Kansas Experiment Station cut alfalfa when about ten per cent of the plants were in bloom, when fifty per cent were in bloom, and again when in full bloom or a little beyond full bloom. Then digestion experiments were made of each lot of hay, resulting in differences of but 1.74 per cent in the total amount digested from either hay, but giving the highest digestibility of protein from the earliest cut and the lowest from the

latest cut, while the digestibility of the carbohydrates was found to be reversed.

The analysis given in the table is from the earliest cut hay. This compared with wheat bran from Henry's Feeds and Feeding gives one per cent more of digestible protein, practically the same digestibility of carbohydrates and half as much aether extract. Thus the amount of nutrient in an equal weight of early cut alfalfa hay is equal in amount and value, or is even a trifle more valuable than the wheat bran.

Prairie hay contained about four per cent more carbohydrates and two-thirds of one per cent more aether extract than did alfalfa hay cut in the early bloom, but less than one per cent of digestible protein was found in the prairie hay. This last may be an error, as only one determination of digestibility was made. There could have been but a small percentage, however, since the hay contained but 3.62 per cent of crude protein.

Timothy hay, one of the best market hays, contains practically the same amount of aether extract, four per cent more carbohydrates and only half as much digestible protein as the alfalfa hay.

This sample of alfalfa hay was cut when the crop was only ten per cent in bloom. This early cutting gives the richest hay and gains time for the second cutting. No less than two and often three cuttings should be expected in Wyoming.

The relative value of prairie or native hay with alfalfa for sheep feeding has been shown in a practical way by Foster (Sta. B. No. 47): Prairie hay per acre, $.44; alfalfa at $14. This was the proportionate value as determined by yields of hay in each case and the use made of them by lambs experimentally fed.

The time to sow, and kind of seed, has been discussed (Sta. B. No. 43) as well as alkali soil, irrigation for alfalfa, and preparation of soil, etc. (Ibid.)

Alfalfa sod is undoubtedly a valuable predecessor for other crops. (See Sta. B. No. 44.)

These few points may be safely urged for alfalfa in any part of Wyoming where any crops are habitually cultivated:

1st.—It is a hardy perennial capable of holding the ground for many years when once well established.

2nd.—It may be depended on as no other forage plant can for large yields of exceptionally rich forage.

3rd.—The nutritive value of alfalfa hay entitles it to rank far above other kinds of hay and to be classed with wheat bran, oats and wheat in nutritive value.

4th.—In making comparisons of values with other kinds of hay, Coburn of Kansas has constructed the following table, a study of which will prove instructing to every thoughtful stockman:

Value per ton when prairie hay is worth per ton.

	$2.00	$3.00	$4.00
Alfalfa hay (average)	$6.05	$9.08	$12.11
Red clover	3.88	5.82	7.77
Timothy hay	1.65	2.48	3.31
Alfalfa hay containing 12.09 per cent protein	7.36	11.05	14.73
Wheat bran	7.02	10.53	14.04

Several articles have been omitted here which were included in Mr. Coburn's table (Alfalfa, F. D. Coburn, Orange Judd Co., 1901).

5th.—Alfalfa hay not only has a high nutritive value, but it is very palatable to all classes of live stock and is therefore eagerly devoured by stock. Even poultry and pigs are benefited by an addition of alfalfa to their rations.

6th.—The beneficial effects of alfalfa on a piece of land will be felt by the crops for several years after the land has been turned to other uses; and,

7th.—Hence, alfalfa is a very desirable crop to occupy several years in a rotation.

A few rations suggested which will approximate pretty closely to the amount of actual digestible food neeeded by horses

of 1,000 pounds weight at different kinds of work:

Horses at Rest.	Horses at Light Work.	Horses at Hard Work.
10 lbs. alfalfa hay	12½lbs. alfalfa hay	12½lbs. alfalfa hay
10 lbs. native hay	10 lbs. native hay	10 lbs. native hay
		*5 lbs oats
		*5 lbs corn

*These weights of corn and oats are about equivalent to 6 quarts of a mixture of corn and oats in equal parts by weight.

FRANK E. EMERY,
Vice Director.

NUMBER 4. TURKEYS IN WYOMING.

Who has had experience enough with turkeys in this state to decide whether they can be profitably raised by his neighbor or not?

That this valuable bird can be raised with profit in nearly all parts of the United States is probably true. Your trials and experience in raising turkeys here in Wyoming, with notes on success, to what due, and also on failures, from whatever cause, are desired. Write us your experience. We wish to know the chief difficulties.

The Wyoming Experiment Station has a few Mammoth Bronze Turkeys for sale at $7.50 per pair or $10.00 per trio, or a few would be let out on shares to successful and reliable poultry women at no great distance from Laramie.

Birds shipped on receipt of price, or terms given on receipt of inquiry.

WYOMING EXPERIMENT STATION,
Laramie, Wyo.

NUMBER 5. WHAT IS A MAINTENANCE RATION FOR A HORSE?

In order to determine how much hay is required to maintain the University horses in winter, the following trials of feeding and weighing the horses were made:

These horses are fed no grain. The stable feed is alfalfa hay. They are occasionally harnessed, but not worked much.

Ordinarily these horses have been running out and have had free access to water and to a straw pile.

Under these circumstances the gray pair, Ben and Doc, were fed in the stable twice daily all the hay they would take. The hay was weighed for thirty days, Jan. 7th to Feb. 7th, both dates included, but excluding two days, Jan. 23rd and 24th, on which they were doing light work at the University. The hay consumed was, for Ben, 493 pounds, and for Doc, 443 pounds.

Both horses were weighed Jan. 7th, 8th and 9th, also on the 16th, 17th and 18th, and 28th, 29th and 30th of January.

Ben was off weight on the 16th-18th. His average was, at beginning, 1093½, middle weight 1060, and near the close of this trial 1110 pounds. The average of the three weights is 1088, but we choose to use the two averages, leaving out the lighter weights, and these give 1101½ pounds. Doc weighed 1080 on seven of the nine times weighed and on the two other dates was five and three pounds lighter. This gives 1079 pounds as an average weight.

Taking the weight of either horse in the proportion:—Weight of horse is to 1000 as the weight of hay eaten per day is to X—gives for Ben, from a consumption of 16.43 pounds per day, 14.92 pounds of hay eaten per 1000 pounds of live weight. Doc ate 14.76 pounds of hay per day, which amounts to 13.68 pounds per 1000 pounds live weight. The average for both horses was 14.3 pounds of alfalfa hay per day per 1000 pounds live weight.

The bay team, Bill and Nell, were also fed and weighed the same as were Ben and Doc. Weights were taken on the same dates. These weights show that both were off weight during the middle of the feeding, but that both gained during the period. The average of the three weights taken on the last of the three dates was for each one of the pair:

	Bill *lbs.*	Nell *lbs.*
Jan. 9th	1155	1335
Jan. 18th	1130	1253
Jan. 30th	1187	1335

In making an average as above for Ben and Doc, we prefer to use the first and last weights. In the above case, if the middle weights are included, the weights of hay per 1000 pounds live weight would be increased by one-tenth of one pound. We are inclined to think the horses were maintaining, or gaining, weight under this feeding and that to ignore the lower weights gives the closer results. Dropping the middle weights, the hay consumed per thousand pounds, live weight, was, for Bill, 13.65 and Nell, 12.303, when these horses ate 479½ and 492¾ pounds, each, in thirty days. Therefore, these four horses, when given their freedom most of the time, with liberty to eat at a straw stack whenever they chose to do so, and with scarcely no work, consumed an average of 13.5 pounds of good alfalfa hay per day.

STRAW REQUIRED TO BALANCE AN ALFALFA HAY RATION.

The horses ate straw very regularly during the above feeding trials and it seems that they needed more carbohydrates than alfalfa hay furnishes for a maintenance diet where the ratio of carbohydrates should be not far from 7 or 8 to 1 of protein, while the ratio in alfalfa hay is little more than 3 to 1.

Ben and Doc were accordingly put in the stable and fed alfalfa hay morning and evening and were given an ad libitum feed of straw during the day.

We take twelve days of this feeding with alfalfa hay and oat straw, since from the effect of the season the grain did not fill well, hence, doubtless, more of the material gathered to fill the kernel must have been left in the straw.

These horses consumed the amounts of hay and straw following their weights as given below:

	BEN *lbs.*	DOC *lbs.*
Weights, Feb. 13th	1090	1075
Weights, Feb. 14th	1080	1077½
Weights, Feb. 15th	1070	1075
	1080	1076

Weights, Feb. 23rd	1120	1080
Weights, Feb. 24th	1125	1082½
Weights, Feb. 25th	1120	1077½
	1122	1080

Alfalfa hay eaten in 12 days	194	166½
Alfalfa hay eaten per day	16⅙	13⅞
Oat straw eaten in 12 days	29½	29½
Oat straw eaten per day	2.46	2.46

Here we find that Ben ate 14.68 pounds of hay and 2.23 pounds of straw per 1000 pounds of live weight and that he gained 44 pounds in weight during the twelve days.

During this period, Doc ate 12.85 pounds of alfalfa hay and 2.28 pounds of oat straw per 1000 pounds of live weight. The average for the two was 13.76 pounds of hay and 2.25 pounds of straw per 1000 pounds live weight, or, we may put it, 13¾ pounds hay and 2¼ pounds of straw.

While Ben and Doc were receiving straw, Bill and Nell were fed only the alfalfa hay in the barn and were out where they had the regular access to the straw pile. Two mornings and one night feeds were omitted necessarily and the night feed for the following night has been omitted. The horses strayed away; thus, ten days are given for this comparative period, with the three average weighings of both at the beginning and end. The weights are always before feed or water is given in the morning.

Each horse ate 160 pounds of alfalfa hay in the ten days taken. The average weight of each was:

	Bill *lbs.*	Nell *lbs.*
Feb. 13th to 15th	1166⅔	1316⅔
Feb. 23rd to 25th	1174	1325
Average for this period	1170	1321
Average hay eaten per day	16	16
Average hay eaten per day per 1000 lbs. wt.	13.68	11.81

The average amount of hay eaten was 12.74, or 12¾ pounds per day per 1000 pounds live weight. Straw was eaten at will during every day.

Calculating the ration of straw and alfalfa hay eaten when the gray horses were fed all they would consume in the stable, we have compared it with the standard as laid down in standard books for light work. These horses were practically at rest. They were led out to be weighed and watered. We can not doubt but that when running out with access to the straw pile much more straw was consumed by each horse than was used in the trial above recorded. The standard and average ration consumed as given above are compared in the table below.

The feeding and weighing of horses was done by Superintendent of Farm, E. E. Sigman.

	Total dry matter	Protein	Carbo-hydrates (N.-free extract)	Fat, Ether extract	Nutritive substance	Ratio 1:
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	
Standard ration for light work for horse of 1000 pounds weight	20	1.50	9.50	.40	11.4	7
RATION						
Of alfalfa, 13¾ lbs.......	12.54	1.82	5.40	.122		
Oat straw, 2¼ lbs	2.04	.027	.87	.018		
	14.58	1.85	6.27	.14	8.26	3.5

The horses have maintained their weights on the rations given above and with what exercise they were inclined to take, when not lightly worked or shut in barn with gray team, while feeding on this calculated ration with straw.

The ration of alfalfa hay and straw is probably better than it looks in the table. Practically, we have found it a good maintenance ration and sufficient for light work.

In digestion experiments at the North Carolina Station, it was found that there was a higher digestibility of carbohydrates when rations rich in easily digestible protein were submitted to experiment.

The protein from alfalfa hay may fulfill the same conditions, in which case there would be more pounds of carbohydrates digested from the straw in the ration given above and

the nutritive substance would be correspondingly increased and the ratio wider than is shown in the table.

FRANK E. EMERY,
Vice Director.

NUMBER 6. THE EFFECT OF DIFFERENT AMOUNTS OF WATER USED IN IRRIGATION UPON THE YIELD OF POTATOES.

In connection with general work in determining the duty of water for various crops according to the usual practice of the irrigator, the Wyoming Experiment Station has carried on some experiments during the past two seasons to determine what effect the insufficient and excessive use of water, as commonly understood, has upon the yield of potatoes.

A more full account of the experiment will be produced in a bulletin to appear shortly, the facts and results being given briefly here.

The potato crop is one which can be grown quite successfully under our conditions, and a more thorough knowledge of its moisture requirements will be of value in aiding farmers to make conditions so far as they are able to control them as favorable as possible to the production of a large and profitable crop.

Although the terms insufficient, excessive, and correct are used in describing the different amounts of water used, still it is only in a relative sense. Practically nothing is known as yet regarding the correct amount of water to use to produce maximum yields or the times at which this water should be applied. The experiments here reported being mainly to determine if the usual practice is or is not the best, the amount of water which a skillful irrigator thought correct is taken as the standard and amounts which in his opinion were not enough or too much to produce the best crop are termed insufficient and excessive, respectively.

While such an experiment depends more or less upon the

judgment of the irrigator and must for this reason be more or less unsatisfactory, still it is thought that the variation in the yields produced by the use of varying amounts of water is shown very well. The irrigator was not limited to the amount of water he should use or the time at which he should use it, he merely being instructed to irrigate one plat with what he considered the correct amount of water and on the others apply larger and smaller amounts respectively.

The plats were laid off adjacent to each other so that conditions of soil, temperature and the like should be nearly similar, and all plats were planted with a uniform quantity and kind of seed. The plats are designated respectively as A, B, and C. Plat A was intended to receive an insufficient amount of water, Plat B the correct amount and Plat C too much.

The resultant yields do not represent the average in this locality, as hailstorms in the forepart of each of the seasons in which the work was carried on seriously injured the growth of the plants. The average yield in years when conditions have been normal has been over 100 bushels per acre, but the largest yield in the last two years upon the plats experimented upon has been but 90 bushels per acre. The comparative value of the results was not impaired, however, for each of the plats was affected alike and the growth which the plants made after the storm indicates the comparative value of the treatment which each of the several plats received.

The yields from Plats A, B and C in 1900 were of both marketable and small tubers, 1176, 2230 and 3069 pounds per acre respectively, and the corresponding depths of water received by the plats from irrigation and rainfall were approximately 5, 7 and 10 inches. In 1901 the yields on the respective plats were 3332, 3956 and 5432 pounds per acre and the corresponding depths of water 17, 8 and 48 inches.

The results show for both seasons that the plats receiving the largest amounts of water gave the largest yield of marketable tubers and the greatest total weight.

A point of considerable interest is the variation in the amount of water which in the opinion of the farmer was correct, too much, and not enough. In 1901 the plat supposed to have received an insufficient amount of water actually received five times as much as the plat which was supposed to have been irrigated correctly. This is an illustration of how widely the irrigator's judgment may vary as to the water requirements of the same crops under precisely similar conditions. It must be said, however, that in both instances the plats supposed to receive an insufficient amount of water gave the smallest yields. Perhaps the most interesting thing found in the results is the relation between the yield per acre inch and the total amount of water supplied. While in both seasons the heaviest yield was produced by the largest amount of water, still it would have been produced at a considerable loss had the water been of any great value. It will of course require a large number of experiments to determine the maximum economic value of, for instance, one acre inch of water for various crops under different conditions. However, for potatoes and for the experiments of the last two seasons at Laramie, the largest yields per acre inch seem to have been produced when from 7 to 10 acre inches was applied. An acre inch is such an amount of water as will cover an area of one acre to a uniform depth of one inch.

Where farmers are so situated that they have to buy water, or during seasons of drouth, a relation like the above, showing the amount to apply to produce the largest crop with the least expense for water will, when well established, be of a great deal of value in aiding farmers to make the best use of a limited volume of water.

Of course the results for these two seasons are by no means conclusive. The amount of water which one plat received, sufficient to have covered it to a depth of three and one-half feet, seems enormous, yet this plat produced the largest yield of potatoes, and the difference in the table qualities of the potatoes from this plat and from those receiving smaller

amounts of water is said not to have been perceptible. It is possible that a still greater amount of water supplied would have produced a still greater yield. There is a limit, however, to the amount of water which should be applied to a crop, an excessive amount of moisture not only injuring the soil in many ways but also giving a product which is apt to contain too large a percentage of water. This is particularly true of potatoes and to some extent holds true also for other crops.

It is proposed to carry on studies such as the above for a series of years, thereby eliminating the accidental variations due to season. Hereafter, however, it is proposed to apply certain definite amounts of water at certain definite times and by this means it is hoped that the moisture requirements of crops during the period of growth may be determined, as well as the maximum yield which can be attained by the application of large amounts of water under certain conditions of soil, temperature, etc., and the amount of water to apply to most economically produce a crop.

BURTON P. FLEMING,
Assistant in Irrigation.

NUMBER 7. THE MANAGEMENT AND IMPROVEMENT OF THE RANGE.

Stock raising is and will always remain the leading industry of Wyoming. With ample pasturage for the stock during the spring, summer and autumn and a sufficient supply of hay as a reserve for winter use, this industry is a profitable one in the state. How to utilize the grazing lands and at the same time preserve their stock-supporting capacity unimpaired from year to year, and how best to restore overstocked and depleted ranges to their former productivity are questions of vital importance to the stockmen.

There is no doubt but that the range may be grazed the year around without injury if the number of animals be small, but, when stocked to its utmost capacity, it is imperative that

it be given a sufficient period of rest during the growing season. This would necessitate a division of the grazing lands into a number of fields and a pasturing of these in rotation. In this way it is possible to maintain the productivity of the grazing land, and with such treatment a more economical use is made of the pastures. An intelligent management of the pastures is readily instituted on individual or corporate holdings, but how to guard against the deterioration of the open range through injudicious practices is still an unsettled question.

In the improvement of deteriorated grazing lands other means than that of rest must be employed in order to more speedily restore them to their former forage value. Unless enough grass remains to reseed the land, rest alone will not bring about the desired result. The range must be reseeded to pasture grasses whose merits are well known, and which are adapted to this region.

What grasses to use and how to seed them are questions which confront the stockmen. No grasses better suited to this climate or of more value for grazing purposes can be found than some of those growing naturally in this region. The native grasses are the ones to use, and these may be supplemented by such "tame" sorts as are adapted to our arid lands. A few of the grasses growing without cultivation in the Rocky Mountain states have already been domesticated, and seeds of these are now on the market. Many other promising ones are being grown experimentally in many grass plantations, and confidence is felt that seeds of the better ones will be procurable from seedsmen in the near future. Many of these produce seed quite abundantly and stockmen can, therefore, collect seeds of them to sow on the range. The stockman ought to be well informed on the grasses and forage plants of his own locality, and it would be a most commendable thing if he would experiment for himself and grow on a small scale those native sorts which he considers especially valuable.

In the reseeding of the range it would be too expensive

and entirely impracticable to prepare an elaborate seed bed, yet it is best to aid the seed in securing a lodgement in the soil favorable to its germination and growth. The most practicable means to employ is to use a fine-toothed harrow or a disk harrow, or both. After the seed has been sown broadcast the harrow should be weighted and driven over the field in one or two directions. The best results will be obtained if the reseeding can be done while the ground is moist, or before a rain, and on account of the shortness of the season spring rather than fall sowing is recommended for this region. The cultivation given the land by this method of reseeding not only covers most of the seed sown, but is beneficial to such grass as is already present on the land. One practice is to sow the seed when the ground is wet and then drive stock over the land to work it into the soil. The method may be employed whenever practicable and will give good results.

The restoration of an exhausted piece of land by reseeding cannot be accomplished in one or two years. During the first season the young seedlings will make but a small, leafy growth on the surface of the ground, and most of our native species, at least, would not head out. Several seasons would, therefore, very probably be required for the grasses sown to grow sufficiently to afford much pasturage. The range will need to be managed carefully, while being renewed, in order that the desired result may be attained.

Harrowing, alone, without any sowing of seed, greatly improves the range. This, to be most effective, should be done in the spring when the grasses start to grow. The cutting up of the sod and the loosening of the soil is conductive to a more vigorous growth of the grasses, and the cultivation thus given to the land is favorable to the germination of such seed as may have ripened on the range. When the disk harrow is used the gangs may be set slanting. This will turn up the soil somewhat and thus help to hold some of the rainwater which would otherwise run off the land. In order to retain as much as possible of

the rainwater the disk harrow may be run on the level, or, in other words, at right angles to the course which the water would take.

Much may be done to place the range in better condition. Some stockmen have practiced a systematic grazing of their fields in rotation and have noted a marked improvement in forage value as the result of such management. Certain stockmen never graze each field for a longer period than three months. Alternate resting and pasturing allows of a recuperation, which is essential to the life of the grasses. At Abilene, Tex., where experiments in range improvements are in operation, disking was found to improve pasture land 25 per cent. The disking cost 40 cents per acre and from the results obtained was considered profitable. Stockmen will find it to their interest to practice systematic resting of their grazing land and to improve the same by harrowing and disking.

ELIAS NELSON,
Assistant in Horticulture and Agrostology.

April 5, 1902.

[The above is a condensed article from a series accompanied by cuts of some of the best grasses for this and adjoining states. It is expected that when the cuts are prepared a bulletin will be published containing the complete article and the cuts.—F. E. E.]

NUMBER 8. WHAT AILS THE CHICKENS?

This is the season when the old hens as well as young chickens need some special attention. There are often losses of chickens due to an unsuspected cause—lice.

There are several varieties of these parasites and they draw heavily on the vitality of the old as well as the youngest fowls. When every one on the ranch has been fully occupied during a busy season these small matters are overlooked and chicken lice become painfully numerous. They multiply rapidly in warm weather.

The most effective way to destroy this kind of vermin is to use some of the coal tar products, or any non-poisonous insecticide as sheep dip, camphenol, chloro-naphtholeum, Miller's Fluid, or other similar compounds. These, in quite a dilute solution, are effective in destroying the vermin on fowls, sheep or cattle.

The solution should be warm and should be used in the early part of a warm day for fowls. Chloro-naphtholeum, Miller's Fluid or Lincoln Dip should be used in proportion of one to one hundred of water. Make enough of the solution to allow for some waste and thoroughly wet every fowl. For a flock of 30 to 50 fowls 10 to 12½ gallons will be sufficient. This may be contained in a half-barrel tub. To dip a fowl and succeed in wetting it with least danger of the fluid being drawn into the lungs hold the weight in one hand grasping the fowl's legs and draw it downward and backward through the fluid. The other hand may be holding the head above the surface, but care should be taken to wet the head thoroughly. When the fowl has been turned in the fluid and moved up and down a few times hold up over the tub by feet to drain the fluid back and wet any part which may have escaped the bath by the flow of the fluid toward the head against the feathers.

When all the fowls have been dipped and turned out in the sun to dry themselves in a warm corner take a small force pump, or lacking that a squirt gun, (which the boys know how to make) a short-handled corn broom, or a white-wash brush and drench the walls, roost and floor of the poultry house with the remaining solution.

After six or eight days do this all over again to destroy the vermin which will have hatched out in that time and the season's work on fowls for vermin will have been nearly done. If the solution has been made of the proper strength no harm will have been done to fowls and the vermin will have been exterminated, if every fowl has been treated and the second treatment has followed the first with equal thoroughness and accuracy as to strength of solution used.

TO SECURE MORE EGGS IN FALL AND WINTER.

A little extra feed as moulting time comes on will pay well in hastening the advent of new feathers and in the greater number of eggs which the hens will lay after the help in moulting.

If flax has been raised, or if linseed meal or oil meal is at hand two or three ounces per day for a few days will help the moulting. This should be scalded and then mixed with the other food.

Young turkeys moping around overcome by the fatigue of the long trip given them by the mother turkey may be revived by gently cramming them with small boluses of food of a soft character that can be rubbed down their throats easily. The young things are weak from walking and growing feathers and are too tired to eat. In this condition they give up and die. A little judicious stuffing saves them.

FRANK E. EMERY,
Vice Director.

June 20, 1902.

NUMBER 9. ALFALFA VS. WHEAT-BRAN FOR MILCH COWS.

A neighbor's milch cow that had been in production since June, 1901, was used for this trial. She was yielding 8¾ quarts of milk, on a daily ration of 22 pounds of native hay and 8.1 pounds of wheat-bran. This was determined by weighing the food and product carefully for ten days. It was proposed to change the food by substituting alfalfa hay for part of the wheat-bran to note the effect of this substitution on the yield of milk.

Wheat-bran and alfalfa have a very similar composition and very nearly the same amount of digestible constituents.

Digestible nutrients in 100 *pounds of*:

	Ash *lbs.*	Crude Protein *lbs.*	Nitrogen-free Extract *lbs.*	Fat *lbs.*	Ether Extract *lbs.*
Alfalfa	6.1	13.24	39.26	....	0.89
Wheat-bran		12.02	39.02	....	2.7

The alfalfa has the advantage in protein, and wheat-bran in fat. Wheat-bran is well known to be a very efficient food for the production of milk. On the other hand, considerable of the relative energy of the alfalfa is used up in the extra work necessary to chew it and pass it through the system.

For the ten days next succeeding the period on which the weights of food and milk were determined, the bran was reduced to three pounds and alfalfa hay was fed freely mornings and hay of native grasses at night, for ten days. The food consumed during this period was: Wheat-bran, 3 pounds; alfalfa hay, 13.97 pounds; native hay, 11.91 pounds. This ration contained 5.1 pounds less of bran and only 3.88 pounds more hay than did the former.

The yield of milk was gradually reduced. The lowest daily yield, on the seventh day, was 15.7 pounds, the average for ten days being 16.87 pounds, or 7⅘ quarts. This shows nearly a quart of milk a day less than during the previous ten days. This period is not long enough to be sure that some recovery might have resulted when the cow's system had fully accommodated itself to the change of food.

During the next ten days a return was made to the original ration, nearly 8 pounds of wheat-bran, with hay of native grasses fed *ad libitum*. During this period, 22.78 pounds of hay was consumed per day. The yield of milk advanced slightly, but enough to show a plain, though slight, advance to 17.16 pounds, or 7.9 quarts.

The average cost and production of the first and third period, when alfalfa was a part of the ration, and a small amount of wheat-bran was used, cost was only 17.44 cents per day. This produced 7⅘ quarts of milk. The lower yield was at a lower cost by 5 6-7 cents when hay was worth $10 per ton and wheat-bran $1.50 per cwt. on the local market in Laramie.

The larger amount of bran produced the highest yield, but economy of production was with the alfalfa ration.

FRANK E. EMERY,
Vice Director.

April 5, 1902.

NUMBER 10. MAINTENANCE RATION FOR DRIVING HORSE.

Some time after the test of rations for idle farm horses was made a similar test was made with the driving horse, Fred, except that this horse was not weighed. The weight taken at several times has been 1170 to 1200 pounds.

For this test we may estimate the weight at and calculate the ration at one-sixth above that for 1000 pounds weight.

This horse is a fair traveler and his drives have been during and just before this test out to the University Farm and back to the University, nearly or quite six miles, or about the same time on the road in some other direction. While out on the road the pace has been well up to the limit of his road gait. So this test was made with a driving horse at moderate work. The difference between consumption of food when at rest by the farm horses and by this horse worked on the road every day is notable. (See Press Bulletin: "What is a Maintenance Ration for a Horse?")

There is every external appearance that the food sufficed to support the horse and maintain his weight, but he did not seem to gain in weight. Apparently this ration was equal to the work required of the horse.

	Total dry matter *lbs.*	Protein *lbs.*	Carbohydrates *lbs.*		Fat *lbs.*	Nut. Sub. *lbs.*	Ratio 1:
21¼ lbs. alfalfa..........	19.386	2.814	5.529	2.814	.189	11.346	
3 2-5 lbs. straw	3.08	.041	1.515		.027	1.583	
	22.466	2.855	9.858		.216	12.929	3.64
6	3.744	.476	1.643		.036	2.155	
As fed, per 1000 lbs. live wt.	18.722	2.379	8.215		.180	10.774	
Standard for 1000 lbs. at light work..	20.	1.50	9.50		.40	11.40	7.0

Regarding this driving as light work this ration approximates quite closely to the standard. That is, in dry matter it falls one and a fourth pounds short but in protein contains an excess of nine-tenths of a pound while in carbohydrates and

fat there are deficiencies of one and a fourth and two-tenths of a pound respectively. This last amounts to fifty per cent of the fat as laid down in the standard.

As noted in a previous bulletin we may consider that the carbohydrates of the straw was digested better than is indicated by the calculated ration and hence that nutritive substance and ratio are nearer the standard than the figures seem to indicate.

FRANK E. EMERY,
Vice Director.

April 25, 1902.

NUMBER 11. EXTERNAL PARASITES OF SHEEP.

Treatment of these parasites is necessary wherever sheep or goats are kept in numbers. The life history of these pests is well known and need not be repeated here.

Flock masters should have "Animal Parasites of Sheep," by Cooper Curtice, M. D., D. V. S., issued in 1890 by Bureau of Animal Industry, U. S. Dept. of Agriculture, from which the following has mainly been gleaned.

These pests consist of, 1st:—Two flies, the Sheep Gad Fly (*Oestrus ovis,* Linn.), and the Sheep Tick (*Melophagus ovinus,* Linn.), which is a wingless fly.

2nd:—Sheep and Goat Lice—Sheep Lice (*Trichodectes sphaerocephalus,* Nitzsch), and Goat Lice, (*Trichodectes limbatus,* Gervais), and (*Trichodectes climax,* Nitzsch).

3rd:—Itch or Scab Insects, The Head Scab (*Sarcoptes scabiei,* De Geer, var. *ovis*); The Common Scab (*Psoroptes communis,* Furst, var. *ovis*); The Foot Scab (*Chorioptes communis,* Verheyen, var. *ovis*). The lice and scab insects have eight feet and belong to the order *Acarina* and are related to spiders.

All these but the Gad Fly may be treated and destroyed by dipping.

The Sheep Gad Fly is a torment to sheep during the hot

weather of midsummer. For large numbers of sheep there is no known remedy that is at all effective in destroying this fly and protecting the sheep. For small flocks tar or one of the several mixtures may be used at frequent intervals and some relief may be obtained. These can be used for small valuable flocks. For large flocks it is best to send the worst cases to the shambles and allow the others to run their course.

DIPPING FOR TICKS AND SCAB.

Dr. Curtice says in part: "The chief poisons used in dip are tobacco, arsenic, and carbolic acid. Of these, tobacco is the favorite, because its use has not been followed by the fatality that has in times past followed the use of arsenic. Carbolic acid is too expensive to be used in large quantities, but is an excellent ingredient when only a few sheep are to be dipped.

The addition of tar to these dips is excellent, as the tar water is not only good for the wounds but serves an excellent purpose in driving away the flies.

The quantity of dip required for each sheep is variously estimated at from one quart to one gallon. For small numbers of sheep, say fifty or one hundred, the larger amount is necessary, but for large flocks, 1 quart for shorn and 2 for unshorn sheep may be allowed. It is always best to have more of the ingredients on hand than is necessary so they may not be used up before the dipping is finished and thus delay the business. To make the dip more effective the solution should be administered quite hot. The most desirable temperature is from 100 to 110° Fah., which is a comfortable one for the sheep, whose internal temperature is about 103. The warmth enables the dip to penetrate the oily wool better, makes the parasites livelier, and proves far more efficient.

Instead of treating the scab by one application some authorities advise the use of a preliminary dip of alkaline water to soften the scabs, or of oil or glycerine well rubbed in for the same purpose. This is to be followed in two or three days

by a poisonous dip. Nearly all advise that the scabs should be rubbed with a stiff brush while the sheep is being dipped."

Dr. Curtice enumerates many dips, but the following he quotes from Stephen Powers in American Merino for 1887:

"Texas and New Mexico—Thirty pounds of tobacco, 7 pounds of sulphur, 3 pounds of concentrated lye, dissolved in 100 gallons of water. Nevada—Sulphur, 10 pounds; lime, 20 pounds; water, 60 gallons. California—Sulphur, 4 pounds; lime, 1 pound; water, enough to make 4 gallons. Kansas—Sulphur, 22 pounds; lime, 7 pounds; water, 100 gallons.

"Sulphur and lime is probably the cheapest recipe, but the lime is apt to injure the staple, still this recipe appears to prevail over all others in the scab infested regions. Probably tobacco and sulphur form the best combination known for the treatment of scab. To every 100 gallons of water there should be 35 pounds of good strong tobacco (if stems or other inferior parts are used there should be more), and ten pounds of flowers of sulphur. This preparation used at a temperature of 120° Fah. will kill all acari, ticks and lice, and leave the wool in a healthy condition. To insure thorough work apply a second time in ten days or two weeks."

There are other and more recently tried dips which may rival the last named. We would advise sheep men to look into the merits and cost of the non-poisonous dips for sheep.

Curtice enumerates two kinds of treatment—preventive and curative. We have given the latter above. "The preventive treatment is undertaken before, during, and after the curative. Indeed, if the flock master exercises proper care his flocks will never require the curative treatment, for the disease always comes from transference of the insect.

"*Preventive.*—An infected flock should be quarantined so that it shall not transmit the disease to other flocks, and should be kept from public highways where other flocks may pass, until it can be thoroughly cleansed and cured."

Dipping.—There are so many dipping tanks advertised

and most shepherds having already had occasion to dip, so we only suggest that the dipping tank should be so set that the sheep come to it down a slight incline. That the dip be kept deep enough in the tank so each sheep is immersed and is obliged to swim a few feet to get out on the rising incline, which is quite long compared with the approach and fitted with water tight floor so the fluid draining from the sheep will flow back to the tank.

As a means of heating the tank a small furnace to use wood, or coal, or an oil stove could be used. It should be a feasible plan to set the tank in a brick wall so a small fire or the oil stove could be used under it and the dip heated as desired with the least possible handling.

Two or three float thermometers should be purchased with the tank. Cost is about 35 cents each for good ones.

At Fort Steele, Wyo., Messrs. Cosgriff Bros. have a turntable approach to the dipping tanks. The central part on this turntable bears several gates which assist in dividing the sheep into squads and hastening or retarding their movement from the yards as may be needed. Men stationed along the line of movement bring up the sheep or squeeze the dip out of the wool as those dipped climb the incline leading out of the tank.

Every user of a tank should carefully select a dip free from anything which can hurt the fibers of the fleece or be poisonous to the sheep.

The dips named above are not all free from objection. The lime dips are injurious. The dips recommended are supposed to be free from injurious properties.

FRANK E. EMERY,
Vice Director.

Laramie, Wyo., July 19, 1902.

GIFTS TO AGRICULTURAL DIVISION OF STATION.

By Harry Quinn, Delano, Calif.—5 Rambouillet Merino sheep, 3 ewes and 2 rams.

By J. E. Springer, Quinter, Kansas.—Small quantity Penicillaria seed.

By E. T. Beltz, Laramie, Wyoming.—1 banana plant.

By A. A. Hoyt—Propless tree props.

By Peter Henderson Company, New York, N. Y.—One 9 mesh to inch Riddle.

By W. Atlee Burpee, Philadelphia, Pa.—Quantity of flower seeds.

By U. S. Consul Henry B. Miller, Newchwang, China.—1 sample lot of Kaoliang, a tall Millet, and Paitzu, another Chinese Millet.

American Glutrose Co., Camden, N. J.—1 gallon Flylene.

Pasteur Vaccine Co., Ltd., Chicago, Ill.—Oxychlorine Plaster, Powder and Tablets.

Nitrate of Soda Propaganda, William S. Meyers, Director, New York, N. Y.—1 bag of 200 lbs. sodium nitrate.

German Kali Syndicate, Dr. J. Von Herff, New York, N. Y.—50 lbs. potassium chloride; 50 lbs potassium sulphate; sent from San Francisco warehouse.

Ezra F. Parker, Peoria, Ill.—Parker's Mam. Yellow Seed Corn.

Iowa Seed Company, Des Moines, Iowa—Sample package Rye-Buckwheat, a new grain.

LIVESTOCK RECORDS DONATED TO THE EXPERIMENT STATION LIBRARY.

American Saddle Horse Register, Vol. III.

American Shetland Stud Book, Vols. I, II, III, IV.

The Guernsey Herd Register, Vols. VI, VII, VIII, IX, X, and parts 50, 51 of Vol. XII.

The Swiss Record, Vols. I. II; Sup. No. I, Vol. III; Sup. No. II.

American Polled Durham Herd Book, Vol. I.

The Hampshire Down Flock Record, Vol. III, IV, V, VI.

The American Oxford Down Record.

The Flock Record of Dorset Horned Sheep in America, Vols. I and II, in one volume.

The Continental Dorset Club Record, Vols. I and II.

The Register of the Vermont Atwood Merino Sheep Club, Vol. I.

The American Shropshire Sheep Record, Vols. I—XV inclusive.

American Rambouillet Record, Vols. I, II and III.

No. 1554.

American Yorkshire Record, Vol. I.

National Duroc Jersey Record, Vols. IV, V, VI, VII.

National Lincoln Sheep Breeders' Association Records.

American Southdown Record, Vols. I—VIII.

American Poland China Record, Vols. I—XXVII.

American Lescester Breeders' Association Records will be presented when needed (i. e., when we have A. L. sheep).

PUBLICATIONS COMING TO THE STATION.

American Florist	Subscription
American Gardening	Subscription
American Sheep Breeder	Subscription
American Agriculturist	Complimentary
American Fertilizer	Complimentary
American Hay, Flour & Feed Journal	Complimentary
American Grange Bulletin & Scientific Farmer	Complimentary
Agricultural Experiments	Complimentary
Boston Society of Natural History Proceedings	Subscription
Breeders Gazette	Subscription
Beet Sugar Gazette	Complimentary
Baltimore Weekly Sun	Complimentary
Chicago Live Stock World	Complimentary
Chicago Daily Drover's Journal	Complimentary

Denver Record Stockman	Complimentary
Elgin Dairy Report	Complimentary
Engineering News	Subscription
Feathered World	Subscription
Flour & Feed	Complimentary
Field & Farm	Complimentary
Farmer's Review	Complimentary
Farmer's Guide	Complimentary
Farmer's Voice & National Rural	Complimentary
Farmer's Advocate and Home Magazine	Complimentary
Farmer's Tribune	Complimentary
Florist Exchange	Subscription
Grand Encampment Herald	Complimentary
Garden	Subscription
Hoard's Dairyman	Complimentary
Homestead	Complimentary
Irrigation Age	Subscription
Indiana Farmer	Complimentary
Kansas Farmer	Complimentary
Louisiana Planter	Complimentary
Montana Stockman	Complimentary
Mehan's Monthly	Subscription
Mirror & Farmer	Complimentary
Massachusetts Plowman	Complimentary
New England Farmer	Complimentary
Nebraska Farmer	Complimentary
Orange Judd Farmer	Complimentary
Operative Miller	Complimentary
Ohio Farmer	Complimentary
Our Grange Homes	Complimentary
Press & Horticulturist	Complimentary
Pacific Rural Press	Subscription
Pacific Homestead	Complimentary
Reliable Poultry Journal	Complimentary
Republic	Complimentary

Rocky Mountain Husbandman	Complimentary
Ranch News for Stockmen and Investors	Complimentary
Southern Farm Magazine	Complimentary
Sugar Beet	Complimentary
Twentieth Century Farmer	Complimentary
The Trade	Complimentary
Up to Date Farming & Gardening	Complimentary
Weekly Statistical Sugar Trade Journal	Complimentary
West Coast Trade	Complimentary
Wool Markets & Sheep	Complimentary
Weekly Live Stock Market	Complimentary
Wallace's Farmer	Complimentary
Western Fruit Grower	Complimentary

Financial Report of the Treasurer.

UNIVERSITY OF WYOMING,
AGRICULTURAL EXPERIMENT STATION,
. . . In Account With . . .
THE UNITED STATES APPROPRIATION, 1901-1902.

DR.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1902, as per act of Congress approved March 2, 1887		$15,000.00

CR.

By Salaries	$ 4,350.17	
Labor	3,731.94	
Publications	1,109.86	
Postage and stationery	573.25	
Freight and express	466.90	
Heat, light and water	624.41	
Chemical supplies	221.75	
Seeds, plants and sundry supplies	276.56	
Fertilizers	7.50	
Feeding stuffs	332.16	
Library	34.85	
Tools, machinery and implements	516.98	
Furniture and Fixtures	388.95	
Scientific apparatus	212.65	
Live stock	861.47	
Traveling expenses	648.81	
Contingent expenses	27.00	
Building and repairs	614.79	
Total	$15,000.00	$15,000.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1902, that

we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been $15,000 and the corresponding disbursements $15,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

Signed: A. C. JONES,
[SEAL] H. L. STEVENS,
T. F. BURKE,
Auditors.

Attest:
GRACE RAYMOND HEBARD,
Custodian.

SUPPLEMENTARY STATEMENT.

DR.	Farm Products	Total
To receipts from other sources than the United States for the year ending June 30, 1902 . . .	$1,157.42	$1,157.42

CR.		
Traveling expenses	322.12	
Buildings and repairs	300.00	
Contingent	205.14	
Publications	330.16—	$1,157.42

Report of the Agriculturist and Horticulturist.

To Dr. E. E. Smiley,
President and Director.

DEAR SIR:—You know so well the condition of this Department when it was taken in charge by me that it is useless to dwell on it. The one experiment of the season with stock was under way and interrupted by too much snow about the buildings. This was restarted. The high fence round the garden was moved back across the Pioneer ditch to stop piling up of more snow when it was not needed. This succeeded.

The lamb feeding experiment was completed and the report of it is now in the hands of the printer. We have been able to do some horse feeding in a way which has been thought worthy of publication as a press bulletin.

During the winter this Department issued four press bulletins on subjects connected with its work. These are leaflets of four pages each designed for immediate circulation among ranchmen and papers which circulate in this state. They can be collected and published together as a regular bulletin when enough of them of sufficient value shall have accumulated for a miscellaneous bulletin. Two others are written and can be issued at any time it is desired to give the papers some Station matter for discussion. One copy of each of these press bulletins accompanies this report.

The work outlined for attention this year is in part a continuation of what has been done in past years and some of it is new to this station and vicinity.

Since the agricultural interests of this state are mainly within the lines of animal husbandry our first efforts are in this direction. We have aimed to begin at the bottom and work up, hence forage crops will be largely dealt with first; then the next most important work taken up is irrigation. Some old ground will be covered here, and it is hoped we can bring re-

sults of accurate determinations of water used in irrigation and follow with logical deductions from them which will be useful to our constituents.

Following the forage crop experiments it has been proposed to institute some digestion work with sheep, and to digest native grasses and forage plants as well as such other forage plants as we may be able to grow successfully and which have not been investigated in this way already by other Experiment Stations. In crop experiments the extensive testing of varieties will be suspended.

The following is a schedule of what has been planned to work on. We may have undertaken too many things and some of them will need to be held in abeyance until more preparation can be made for such work. These would be feeding experiments with crops for which we now have no means of storing where they can be reached and used when needed. Accommodations for animals are also needed for those experiments. But here is the schedule of work proposed to be executed:

STATION WORK FOR 1902.

Agronomy.

1. Grow forage crops to feed lambs from produce of farm in comparison with purchased feed. a, legumes; b, roots; c, grain.
2. Increase best varieties of small grains as farm crops.
3. Make soil test on farm with potatoes; also soil test with a straw crop, too, if possible.
4. Plant few best varieties of small grains.
5. *Forage Crop* in co-operation with U. S. Bureau of Plant Industry. Plant as many plats as possible large enough to yield forage for digestion experiments with sheep.
    a. Test native grasses.
    b. Test cultivated grasses.
    c. Test salt bushes.
6. Compare these same crops on dry range.

7. Observation on the effect of irrigation on the native grasses of prairie land with determination of the optimum amount of water for such land when made into hay meadows. Co-operative Experiment—see Irri. Expt.

   a. Experiments with cultivated grasses sown on the sod of native meadows.
   b. Experiments in methods of tillage for native meadows.
   c. Experiments in methods of tillage for range.
   d. Experiments to determine best methods for planting salt bushes.

8. Carry the work on forage crops through feeding trials.

   a. Comparative practical trials.
   b. Digestive trials with new plants of unknown digestible value.

9. Co-operative work between the Agricultural and Chemical divisions of the station, in which digestion experiments will be undertaken with

   a. The range grasses as they are found, gathered three or four times a year.
   b. Grasses growing on fenced area, to determine the yield and digestibility of the growth on the Laramie plains.
   c. Grasses and other forage plants grown on the Experiment Farm with and without irrigation. See 8b.

Irrigation Experiments.

1. Co-operation with Office of Irrigation Investigations in a study of the utilization of the water supply on a stream where agriculture is typical of conditions at present existing in Wyoming. The stream to be studied this year is Sand Creek, a tributary of Laramie River.

2. Experiments to determine the moisture requirement of various crops by the irrigation of the crop with definite amounts of water, at definite times during the season growth.

3. Co-operating with Plant Industry. See 7 above.

4. Measurement of the water used upon some private farms and upon an established native hay meadow.

The adverse seasons of 1900 and 1901 left the farm without seed except potatoes, of which upwards of $50.00 worth have been sold for seed. Other seeds have been purchased and all the available land of the farm has been put into crop. Seed has cost more than usual this year and purchases have been limited to actual need for good crops on the areas planted. If these crops give satisfactory yields we shall have some home grown grain, oats, peas, vetch, emmer or speltz, to feed in comparison with corn or by-products from oil mills. Also some roots and smaller forage crops on which animals can be fed for digestion experiments.

In the horticultural line plants have been grown for bedding out on the University grounds, vegetables started, and some experiments conducted in germination of seeds which have been slow to start in plat work.

HERD OF CATTLE.

Looking toward the purchase of the stock provided for last year, Prof. Foster did some corresponding with stockmen but bought no cattle.

This season after considerable correspondence with breeders the nucleus for a herd of Shorthorns has been purchased. We have found, too, that for Herefords we do not need to go outside of the state to get as well bred stock as anyone has, and that these can be bought at as reasonable prices within as out of the state. Just where to buy can not be easily decided and several Carbon, Laramie, Sheridan and Johnson County herds should be seen before a final decision and purchase of the stock.

But before any more stock is bought stable and yardroom should be provided. This last is a matter of some importance and it is hoped the Board will take it up for consideration. With the location and erection of buildings and yards is in-

separably connected a sufficient supply of good water. This is not now found at the University Farm.

BARNS AND SHEDS.

At the instance of President Gramm we have made a plan for a basement barn and root and sheep sheds which will accommodate about as much stock as can be well handled regularly on a farm the size of the University Farm. This would contain about 42 thousand feet of lumber and with sheds and yard fences the cost would not exceed $2500.00 to $3000.00.

For any experiment on a large scale with steers, colts, or sheep we shall expect to make special arrangements as was done in the range sheep feeding experiment.

CO-OPERATION WITH DIVISIONS OF U. S. DEPARTMENT OF AGRICULTURE.

Co-operative work with the Divisions of the Department of Agriculture is growing among the Experiment Stations. As a rule with some money furnished which partly pays assistants the Station feels bound to accept co-operation. This may become burdensome finally. In most cases the Station furnishes land labor and other expenses whilst the Department Divisions furnish seed and so much of the pay for the assistant.

This station has one assistant two-thirds of whose salary is thus paid by the Department of Agriculture for forage plant work. The claim on his time objects to his teaching in the College and provides that he be subject to the Washington Division for work in Washington City or in other states for a part of the year. While we agree to the terms of the co-operation there is no redress for any break in our work which might come out of a call for this assistant to spend two or three months away from this University.

For the irrigation work the Office of Irrigation Investigations paid $500.00 to cover expenses for its share in this work last year. Mr. B. P. Fleming, the assistant, is in the line for civil service promotion and is subject to call at any time hav-

ing passed examination with high rank. The University should provide for retaining him when a call comes, or a break may occur at any time in this branch of our work.

COLLEGE WORK.

While the College of Agriculture is now practically without students it is necessary to provide for carrying out the offer of a course in Agriculture that shall be as good as is to be found in sister colleges. We believe the catalogue offers this. In order to give the instruction it will be necessary to draw considerably on the time of both assistants and it would cripple the work to allow any reduction from the present force. As noted above the co-operation work is in opposition to any teaching by the assistants. There is a well founded objection to calling on the Experiment Station men to teach and it is hoped that in time the necessity for this double duty will be withdrawn.

There is an urgent need for more room for the College of Agriculture in the University as well as for suitable rooms for the Experiment Station.

There is one room now available for the Agriculture, Horticulture, and Irrigation work and Vice Director's office, the two assistants and stenographer. This room is provided with blackboards and would become an admirable classroom for Agriculture if the offices, etc., could be removed to suitable quarters. This College and Station as now equipped stands at the bottom of the list of all the Agricultural Colleges and Experiment Stations of the whole country. This is true of the farm as regards buildings and stock and of the College in its development. This statement is made as one of fact and not in criticism. It is a fact to be acknowledged by all when the subject has been examined. But this fact need not exist very long when all members of the Institution work together unitedly to grow up from the present rank to one of which all can feel that more credit is due and toward which we trust every month which elapses will mark some point gained.

Report of Botanist.

The lines of work that have had more or less attention during the year are much the same as those that have been pursued for the past several years. The paramount questions in Wyoming are no doubt much the same that they are in the other comparatively new states of the arid belt. So far as these pertain to botany a few of them are as follows:

1. Forage problems.—A better knowledge of the native forage resources and better methods perpetuating and improving the native species of desirable plants is greatly desired. Field work to this end has been continued. Inquiries received at the station indicate much interest throughout the state in this subject. While it has not been feasible to attend but one of the several stock conventions during the year yet the discussion there of some forage plants developed much interest not only at the time but resultant in many further inquiries by mail as to promising varieties and best treatment of certain lands.

2. Fungi.—The native species of parasitic fungi are still under consideration as well as the introduced forms. From the latter we have enjoyed remarkable immunity, but more and more as agriculture becomes more diversified and horticulture finds a place among our industries the losses from this source are increasing. Inquiry for remedies from several parts of the state indicate that it will be necessary to issue one or two "information bulletins,"—one setting out the advantages and methods of spraying and the other, that ought to accompany it, the method of controlling insect pests.

3. Home making.—One of the serious hindrances to the progress and further settlement and development of the state has been the temporary character of so many of the homes. Often the settlers have merely "camped" in any sort of a makeshift house, with surroundings even worse than the house.

With a better understanding of the state's resources, a tendency to permanency is beginning to be manifested. The improvements are of a more substantial character and some thought is being given to the home surroundings. To accentuate this tendency and to meet a certain demand for information along some lines of home improvement the following phases are under consideration: (a) Making a home vs. staying on the place. (b) Means of improving the home surroundings. As bearing on this phase one bulletin, No. 50, Native vines in Wyoming homes, has been issued this year. (c) Treelessness is a marked condition in a large part of the state, but trees are so vitally connected with civilization and home life that every effort will be made to find the possibilities for their development even under the very unfavorable conditions that too often exist. (d) Home production of table necessities must be in every way encouraged. This state is still in much too large a measure a "tin can" state. The home garden, the poultry yard, etc., need to be improved or in many instances introduced.

4. The native flora.—Work on this continues and a few papers have been published in the botanical journals. A small book called a Key to the Rocky Mountain Flora has been published from this office by the Appleton Company.

Report of Chemist.

My work as Chemist of the Wyoming Agricultural Experiment Station has during the past year comprised three distinct lines:

First, the investigation of the absorption of salts by seeds has been carried on and some very interesting results have been obtained which are not only of value for their bearing on the unknown processes of seed germination, but promise to give some assistance toward solving the problems of the effect of alkali on seeds and plants. A partial report of my experiments was presented to the American Association for the Advancement of Science at its Denver meeting last July, and will be published as a bulletin in a technical journal.

Second, a number of analyses of alkali and alkali waters from the lakes and deposits of Wyoming have been made and published in Bull. No. 49 in connection with geological work on the same subject by Dr. Knight.

Third, the work of analyzing the food products found in Wyoming markets has been undertaken and a bulletin on the extent of food adulteration in our state will be issued in the near future. Since so large a part of the food consumed not only in mining camps and on ranches but also in towns is imported in cans and packages where there is special temptation to use adulterants or preservatives, it is of great importance that the character of these should be reported upon from time to time by some competent and impartial authority. No provision has yet been made in this state for chemical analyses of the foods, drinks, and drugs used in the state, but the work has been begun by the Chemist of the Station, in addition to his other duties, at the request of some public spirited men of the state in the hope that when its importance became known, some form of permanent supervision may be provided for and enforced by suitable legislation.

E. E. Slosson.

Report of Geologist.

During the year terminating June, 1902, I have carried on three lines of research:

1. On the geological range of the alkalies in the state and the position of the various bands in which unusual amounts of alkali have been accumulated. There has also been some attention paid to alkali in soils, and as to the different kinds of alkali that are found in soils that are derived from different sources.

2. A considerable time has been allotted to the study of the origin of soils and especially in respect to their relationship to the wind. A great deal of valuable data has been secured, besides numerous important photographs and much general information. I expected to continue this work for another season and then issue a bulletin upon the subject of the origin of the alkali in the soils and especially to show whether they have been derived from decomposed rocks or have been carried by the water and wind.

3. The work upon Wyoming birds has been finished. Most of the manuscript is in the printer's hands and the bird bulletin will be issued some time during the early fall of this season.

Report of the Meteorologist and Physicist.

Observations have been taken of the relative humidity, maximum and minimum temperatures, pressure of the air, rainfall, snowfall, velocity and direction of the wind, evaporation, percentage of sunshine, and the temperature of the soil at various depths. All observations, except the amount of rainfall and snowfall, are taken each day at 7 a. m. and 7 p. m.

The investigations in regard to the rise of alkali in soils, the evaporation of moisture from the surface of soils, the effect of alkali upon the evaporation of moisture, and the effect of stirring the soil once a week to various depths upon the evaporation of moisture, when the level of water is maintained at certain depths below the surface, have been completed and the results published in Bulletin No. 52.

During the coming year, I hope to continue my investigations on the evaporation of moisture and also to study more extensively the physical characteristics of the soils of Wyoming.

METEOROLOGICAL SUMMARY.

Highest temperature, 92°, July 20.
Lowest temperature, —23°, Dec. 14.
Mean temperature for the year, 40.5°.
Greatest daily range of temperature, 52°.
Lowest daily range, 4°.
Mean daily range of temperature, 25.5°.
Mean relative humidity for the year, 62.2°.
Lowest relative humidity, 11°.
Highest dew-point, 62°.
Lowest dew-point, —34°.
Mean dew-point, 28.7°.
Highest barometer, 23.469.
Lowest barometer, 22.475.

Mean barometer for the year, 23.035.

Highest monthly precipitation, 3 inches, May.

Lowest monthly precipitation, .1 inch, November.

Greatest amount of precipitation during any single storm, .91 inch, June 15.

Total precipitation during the year, 8.52 inches.

Mean precipitation for ten years, 9.45 inches.

Evaporation from Apr. 28, to Nov. 15, 36.379 inches.

Greatest monthly evaporation 9.188 inches, July.

Mean soil temperature, at 3 inches, 46.6°; at 6 inches, 46.1°; 12 inches, 46.8°; 24 inches, 46.6°; 36 inches, 46.9°; 72 inches, 44.7°.

Prevailing direction of the wind, southwest.

Number of clear days during the year, 176.

Number of partly cloudy days, 117.

Number of cloudy days, 72.

Greatest velocity of wind, 70 miles, Dec. 27.

The University of Wyoming

Agricultural College Department.

THIRTEENTH ANNUAL REPORT

... OF THE ...

U. S. Agricultural Experiment Station

... OF ...

WYOMING

1902-1903

LARAMIE, WYOMING,
U. S. A.

Letter of Transmittal.

U. S. AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF WYOMING.

To His Excellency, Fenimore Chatterton, Governor of Wyoming:

SIR:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating agricultural experiment stations, I have the honor herewith to submit the thirteenth annual report of the U. S. Agricultural Experiment Station of Wyoming.

B. C. Buffum
Director.

UNIVERSITY OF WYOMING, June 30, 1903.

Wyoming Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

President of the University of Wyoming.

ELMER E. SMILEY, A. M., D. D.

STATION COUNCIL.

E. E. SMILEY, A. M., D. D................................President
B. C. BUFFUM, M. S.......Director, Agriculturist and Horticulturist
A. NELSON, M. S., A. M.......................................Botanist
E. E. SLOSSON, M. S., Ph. D...............................Chemist
W. C. KNIGHT, A. M., Ph. D...............................Geologist
C. B. RIDGAWAY, A. M................Physicist and Meteorologist
G. R. HEBARD, A. M., Ph. D.............................Secretary
BURTON P. FLEMING, B. S..................Irrigation Engineer
ELIAS E. NELSON, A. M...Assistant in Horticulture and Agronomy
E. E. SIGMAN.........................Foreman Experiment Farm
LUELLA CASE ....Stenographer

Table of Contents.

Report of Station Council.

Report of the Director.

ORIGIN AND PURPOSE OF THE STATION.—The several Experiment Station reports heretofore published have explained the origin and purpose of the Station, giving something of our organization, and the method of working for the upbuilding of the agriculture of the State. Briefly, the purpose of the Station is *research* in agriculture, and the publishing of such bulletins and reports as will enable our people to put to practical use the results of this research. The fact that this expenditure and work is primarily for the benefit of the people of Wyoming does not seem to be so generally understood as it should be. Many do not realize the purport of the fact that the most progressive nations are generously fostering both the theoretical and practical education of those engaged in every agricultural industry. In our own country the two Morrill acts establishing and supporting our Agricultural and Mechanical Colleges provide for the foundation education of our youth, and the Hatch act of 1887 makes an appropriation by Congress of $15,000 annually to each State and Territory for scientific research in agriculture and the dissemination of the results of such investigations to the people through agricultural bulletins, which are sent free upon request for them. Some experimental work was done in Wyoming as early as 1890, and on January 10, 1891, the Legislature authorized the University of Wyoming to receive the appropriation by Congress for the establishment of an Experiment Station. The work of the Station was organized and a

Station Staff elected in March and April of 1891. The results of the Station work and executive details up to the beginning of the last fiscal year are published in the twelve annual reports, the 58 regular bulletins, and the various press bulletins which have been issued.

THE STATION COUNCIL.—The Experiment Station Council is the executive body which passes on all matters pertaining to the Station policy, work and publications. It is composed of the President of the University, as Chairman; the Secretary of the Board, who is Secretary of the Council; the Director of the Experiment Station, as its executive head; and those professors and assistants in the University and Agricultural College who do research work. The Station Council meets regularly on the second Thursday of each month, and additional meetings are called whenever occasion demands.

The Council recommends plans for work in the several departments of the Station and all bulletin material for publication, to the Agricultural Executive Committee of the University Board of Trustees for their adoption. The bulletins as prepared are read and discussed in open council meetings. This plan of passing on the bulletins has given much satisfaction. It prevents extravagant statements and insures a more complete discussion of the results of an investigation than might be made by the writer alone. The subject matter and composition are freely criticised, and the material prepared may be accepted for publication, or referred back to the writer for revision, postponed or entirely thrown out. This arrangement brings the Station workers very closely together, and provides for cooperation along any line of work in which two or more departments may be able to take part. The writer of a bulletin may select two other members of the Station Staff to aid him in reading proof.

TEACHING.—The heads of departments in the Station are also teachers in the University and College. It often occurs

that the teaching requires so much time that but little attention can be given to pure research. While it is true that research greatly aids the teacher and his classes in supplying the student with the latest and best information, this necessity makes it impossible to do as thorough investigation as might be wished. A man who is teaching five or six hours each day has little energy or vitality left to carry on special research. However, the appointment of assistants in the departments gives some relief from this situation. The assistants have little teaching to do, and put the larger part of their efforts on the investigation in hand, under the direction of the head of the department.

SEVERAL DEPARTMENTS IN ONE.—It has seemed necessary in our new State, with its small population and limited funds, to concentrate the work very much. For example, the Director of the Station is the professor of agriculture and horticulture, has direct charge of the work in irrigation and entomology, is expected to look after the farm work and live stock, and will also manage the work in meteorology the coming year. In many institutions each of these divisions is placed in a separate department, with its own head and equipment, and the separate departments are being sub-divided. There is some advantage in concentration, providing the work along the several lines is not cramped by the Board considering it only one department and limiting its funds and help accordingly.

OUR ORGANIZATION AND THE STATE'S AGRICULTURE.—Under this system it has been necessary to carefully organize and systematize the work. At present there are two regular assistants given to the department of agriculture and horticulture. One of these is the Irrigation Engineer, who personally looks after the work and records of that department. The other is assistant in horticulture and agronomy. However, even this organization leaves the Director and professor of agriculture with many responsibilities, and he must spread himself over so many kinds of work and thought that it is practically

impossible to carry on thorough lines of technical research. It is true, however, that the agriculture in Wyoming is very new, and, due to this fact, it is probably also true that the research of our Station has kept ahead of the needs and demands in the State.

The Station has been fortunate in being able to lead in our agriculture, so far as soil culture and crop problems are concerned. Heretofore we have been greatly handicapped in not being able to supply the equipment necessary to lead in the work with live stock, but, as shown later in this report, we are now able to take up this work with a better outlook for the future.

State Chemist.—A new help has also come to the Station in the law passed by the recent Legislature, making our professor of chemistry, State Chemist, and supplying him with an assistant, whose salary will be paid by the State, to do the analytical work for pure food control. Along with this work of the Chemist, much research of interest to the agriculture of the State will be possible, and as a State officer, the Chemist's position will be materially advanced.

Changes During the Year.—At the beginning of the fiscal year the President of the University desired to be relieved from his duties as executive head of the Experiment Station, and the professor of agriculture was made Director. Professor F. E. Emery, who was Vice Director and professor of agriculture and horticulture, resigned, to take effect September first, and the present incumbent was elected Director and professor of agriculture and horticulture, to begin his duties on that date. By mutual consent, the President of the University retains his position as chairman of he Experiment Station Council.

The work of the year in the department of agriculture had been planned and partially carried out by Professor Emery, and the appropriations for the year had been made by the Board

at their June meeting. The amount of money appropriated to the department was small, and it was found necessary to add to the funds in order to carry on the enlarged work the present season. On this account little attempt was made to reorganize the work along new lines. We simply took up the work where it was left, and did what was possible to prepare for new activities when new funds could be appropriated.

Association Meetings.—The Botanist, Professor Aven Nelson, represented the Agricultural College and I represented the Experiment Station at the meeting of the American Association of Agricultural Colleges and Experiment Stations, held in Atlanta, Ga., during the first week in October. The first week in December I attended the International Live Stock Exposition at Chicago. The College and Station was represented at the meeting of the National Irrigation Association at Colorado Springs, Colorado, October sixth to ninth, by Mr. B. P. Fleming. We were represented at the Colorado State Fair and at the meeting of the Wyoming Industrial Convention. As Director of the Station, it is my policy to come into touch with the agricultural interests of the State wherever possible. The various association meetings and live stock organizations are not only a great stimulus to the Stations worker, but keep us abreast of the times in a way which is invaluable.

Meteorology.—By mutual agreement between the professor of physics and meteorology, and the Director, the Board was asked to transfer the equipment in meteorology and the work to the agricultural department. This was accordingly done, and the Irrigation Engineer, Mr. Fleming, will have direct charge of the equipment, observations, records and reports the coming year. It seems proper that this work should be done in connection with the irrigation investigations, which is closely allied to our use of water and growing of crops. This will give some relief to the professor of physics and meteorology, whose

duties have been heavy during the year. Attention is called to the report of the Physicist and Meteorologist, and summary for the past year.

Co-operation.—During the year the Station has carried on some lines of work in co-operation with the bureaus in the Department of Agriculture. We expect to do more co-operative work with our ranchmen in the future than ever before. It seems quite important that we should take up such practical lines of work in connection with a few ranchmen who have sufficient interest in the investigation to aid in it by the use of their lands and stock, and while it will be necessary to confine the work to a few lines, and a few places in the State, the results will be of great value to everyone who will make use of them. So far as has been possible, we have aided our ranchmen in several portions of the State. This has been largely through the distribution of seeds and the dissemination of information and correspondence covering any questions which might be asked. We have freely loaned the implements on the experiment farm, more especially the press drill, the use of which we deem so important in establishing good stands of alfalfa at our high altitudes.

For several years we have been investigating the grass and forage plant problem, and attention is called to the report of the assistant in horticulture and agrostology, published herein. The varieties which we have proved to be suited to our soil and climate in a small way on our experiment farm, we will plant on a few ranches on a larger scale, to demonstrate beyond any question their true value. We hope also to obtain co-operation with stockmen along lines which promise results of greatest importance to our own State. The coming year it is hoped that we may hold a number of Farmers' Institutes in different portions of the State, and our plans provide for one or more short courses at the University in some branch of live stock work the coming winter.

HELP.—During a part of the year the office of the Director was without regular help. Student stenographers were employed a part of the time when they could be obtained. In April the work was getting so far behind that it was deemed necessary to hire regular help. The Executive Committee authorized the employment of a stenographer. On April 20 the present stenographer began work writing for this department and several others as time would permit. At its June meeting the Board authorized a continuation of this arrangement.

The assistants in this department, when I took charge of the work, were Mr. Elias Nelson, in horticulture and agrostology, and Mr. Burton P. Fleming, in irrigation, whose title on our Station Staff is that of Irrigation Engineer. These are both good men, and our records show a creditable amount of work done by each during the year. In order to further all of the interests of the Station, the help in this office has been freely used to aid others in carrying out necessary lines of work, and Mr. Fleming has taught classes through the year in two other departments. The report of each of these assistants has been made a part of this report along with other members of the Station Staff.

THE STATION EQUIPMENT.—Science Hall—Laboratories—Offices. The laboratory facilities have been greatly extended and improved by the occupation of the new $40,000 Science Hall. In January the departments of chemistry, geology and botany moved into their new quarters. The building is an imposing one of white stone, with granite trimmings, situated on one of the best building sites on the campus. It provides class and lecture rooms for the University and Agricultural College classes, and rooms for the student and Station Laboratories, Herbaria and general Museum.

The removal of these departments from the main University building relieved the congestion there, and the Physicist was assigned the large rooms in the basement formerly occu-

pied by the Chemist. The Director and Agriculturist moved into the rooms formerly occupied by the Botanist. This gives the agricultural department the two rooms in the south end of the building on the main floor. One of these rooms is the general office of the Director, and contains the general department library. The other is the office of the assistants in this department, holds the Experiment Station library, and contains work tables, a small dark room for photographic work, and storage shelves for apparatus. The several Station laboratories (in chemistry, botany, physics and meteorology) are now fairly well equipped with apparatus and supplies.

OTHER STATION BUILDINGS.—The Station buildings located on the University campus are a horse barn and a small greenhouse, with potting room and storage room adjoining. On the old Experiment Farm the buildings consist of a small seven-room cottage, a bunk house and tool shed, a shed barn for the work horses, with a vehicle shelter adjoining, a sheep shed and a small hen house.

The newly acquired buildings on the old penitentiary farm consist of a main building, the central administration part of which is about 45 feet by 42 feet. At each end of this are wings 84 feet long by 40 feet deep, the whole substantially built of limestone, with red stone trimmings. This was the penitentiary proper, and the first cost, including the iron work and cells inside, is estimated at $60,000. The Station will not be able to occupy more than one wing of this building until its being turned over to the Station and College is confirmed by the Legislature. There is a brick building also, which has been used as a bakery and store room, and a small stone blacksmith shop. Outside of the stockade inclosure is a house built of grout, containing six rooms, with closets, and a good basement. The other buildings connected with the penitentiary property belonged to the old broom company. The Board has purchased these improvements outright from Mr. N. K. Boswell, using State funds for the pur-

pose, and turned them over to the College and Station for our use. This purchase will enable us to occupy these buildings and remodel and fit them in any way desired, to provide for live stock work. Following is a list of the improvements included in this purchase:

Stable made out of old freight cars and hard wood timbers, 32 by 100 feet, with tin roof and partially floored with hard wood flooring.

Hen house, 24 feet by 80 feet, of railroad cars, with double roof of car covering, divided into pens, with slatted chicken fence.

Stone hen house, 22 feet by 40 feet, with dirt roof.

Stone duck house, 12 feet by 18 feet, with dirt roof.

A railroad car granary.

A railroad car storage building.

A summer kitchen built on rear of house.

Old tannery, 28 feet by 12 feet, with 5 windows and door, shingle roof. Has tobacco shop attached, 28 feet by 12 feet, of remodeled railroad cars.

Heating plant, stone, 30 feet by 18 feet, about 12 feet deep. Roofed with corrugated iron. Contains the steam boilers furnishing the heat to main building and house.

Root cellar, 18 feet by 21 feet. Substantially built of stone.

Small boiler house, 12 feet by 15 feet, with shed roof, attached to broom factory.

Closet in stockade, with sewer connections.

Addition to broom factory, 24 feet by 42 feet, two stories high. Contains 20 windows, 3 outside doors and stairway. Shingle roof.

Ice house, 15 feet by 27 feet. Building of 4-inch by 8-inch timber, with a cement roof.

Pig sties, built of hardwood, railway timbers.

Fencing around the yard, including chicken fence, wire fence for corral at barn and about one-half mile of four-wire fence dividing the fields.

The water and steam pipes connecting the city water system and the heating plant with two outside hydrants and with the house.

The following report was made to the Board of Trustees at its annual meeting in regard to the use of this property:

The Acquisition of the Penitentiary Property and Suggestions for Its Use.

TERMS OF THE STATE BOARD.—On the formal application of Otto Gramm, President of the Board of Trustees, the State Board of Charities passed a resolution on June ninth, turning over to the Board of Trustees, for the use of the Agricultural College and Experiment Station, the old penitentiary grounds and buildings, until March, 1905. The resolution states that the crops planted on this farm this year belong to Mr. Gramm. It also provides that the administration part of the main building and the south wing may be used by the Board of Charities, provided necessity arises, and that the building shall not be dismantled, but that we may have the use of such as are needed to care for our live stock, etc., until the next Legislature may designate what shall be done with the property. The University Board are to take good care of the property without expense to the Board of Charities, and turn it back to them in as good condition as when we receive it. The insurance on the buildings has been paid in advance by the Board of Charities, and is to be kept in force by them.

IMPORTANCE TO THIS INSTITUTION.—The acquisition of this property is one of the most important things in the history of the University. It means so much to the future of the farm and stock interests of Wyoming that, if wisely used, the people must look upon this action of the authorities as one of those wise acts which distinctively mark the early history of one of

the most sound and progressive States in the Union. Acquiring this additional land and the buildings will enable us to begin live stock work in a way which will make it possible to accomplish something that will attract attention and help build up the most important agricultural industry in the West. It will help the University by showing good faith on the part of the State, which receives the federal appropriations for agricultural teaching and investigation. It brings the colleges of the institution into prominence, and will add dignity and force to the agricultural work, than which there is none of greater interest and importance at this time.

Two things regarding this property impress themselves on me at this time. First, it will take legislative action to make this grant permanent to the Agricultural College and Experiment Station of the University, and, second, we must make such good use of the property as will induce the next Legislature to formally and permanently transfer it to this institution.

Use of Funds.—Accordingly, we should use only such of our limited funds for permanent improvements as is necessary to secure those buildings and fences which do not now belong to the State, and to do such remodeling and fencing as is absolutely required to properly care for and manage such stock equipment as we may be able to secure.

The Interest of Our Stockmen Essential.—In my opinion, this is the morning of our opportunity, and with your permission and support, I wish to actively and energetically push the matter in a way which promises more for the institution than we can do ourselves. I realize that our funds which are available in any one year are small, and with them we must do something great. It seems to me that our success as a station depends largely on getting the sympathy and help of our own stockmen and others who have an interest in helping the West. I do not know that we can obtain financial aid from outside parties, but such a thing is not impossible, as such aid has been

and is being extended to other institutions by men who become sufficiently interested and enthused in the possibility of doing something which is really practical and helpful to the country. I hope, by personal solicitation, to get the sympathy and interest of our own influential stockmen. This will insure favorable legislation, and we may obtain donations of stock, or even such support as may enable us, at some early date, to make importations of type animals from Europe. Getting the matter before the people in such a way as to create interest is largely a matter of personal solicitation and advertising. By advertising, I do not mean simply printed statements, but the doing of something which is new, practical and attractive because it promises dollars and cents results.

CATTLE BREEDING.—I would suggest that we make our small beginning with such funds as may be available by introducing a breed of cattle which will be of wide interest. I have investigated the Polled Hereford breed, and believe there is an opportunity for us to obtain a few animals of this type, and, by scientific breeding, help fix and improve a kind of stock which will be of much permanent value to the live stock interests of the State. We should also keep type specimens of other leading breeds, but we should keep nothing but the best, and for some time to come only small herds will be practicable.

HORSE BREEDING.—I think we may also begin in a small way with horses. It is the idea of the Secretary of Agriculture that here in the West we should build up a typical breed of horses, which will be of special value as general purpose animals for ranch and farm use. My personal opinion is that we do not want the heavy draft horse of Europe, with his poor feet and thin hoofs, which do not stand our dry climate, but that we need a medium sized horse, heavy enough to do general farm work, with good feet, endurance and action, which will make him wear well while on the road. I believe this can be done by scientifically breeding some medium heavy horses with

our native mares. The native stock has proverbially sound feet, especially suitable to our dry climate. By an infusion of the best blood, our native horse may be increased in size and intelligence, and a breed fixed by the use of several out-crosses which should produce that type of general purpose animal that is in greatest demand. Such work is not being attempted by any other college or station, and our taking it up would cause widespread interest, because of the practical end in view.

Sheep Breeding.—Just what we will be able to do to keep in touch with the vast sheep interests of the State has not been clearly thought out. We have a small herd of Rambouillet Merinos, and we may be able to carry on experiments in cross breeding which will be of value. Something may be done in an experimental way with lamb feeding as outlined in the plans for the ensuing year. We should consult men in touch with the sheep interests, to determine what action will be of greatest immediate value.

Swine Breeding.—Many people from the middle states entertain an erroneous idea that stock of any kind cannot be fatted for market outside of the corn belt. I believe we will be able to prove the fallacy of this opinion. The bacon hog is attracting wide attention. The characteristics of a bacon hog are his form, which supplies a large amount of this character of meat, and his ability to lay on fat mixed with lean meat in proper proportions. The production of flesh requires nitrogenous food rather than corn fattening. We are able to produce the kind of food for this kind of hog. It will not be expensive to begin with a few head of Tamworths as examples of a bacon breed, and perhaps also with the Polland China or other breed as an example of the lard hog.

Poultry.—Our stock interests are varied and we should touch them all along the line. The new equipment furnishes buildings and yards which have been planned purposely for

poultry work. The company owning them also possess some good flocks of chickens which they desire to turn over to the Station, and as the expense is small, I suggest that we purchase this poultry with which to begin our work.

Dairy Work.—There is some demand beginning to manifest itself in the State for information in regard to milch cows and dairy work. It would be well to have a small equipment for investigation and instruction, making it supplementary to our cattle breeding.

Stock Feeding.—There is no end of work to be done in solving the problems of stock feeding, for the subject has not been touched in a scientific way at this altitude. There is abundant evidence that we will be able to meet with great success in this line of work. Two years ago a car load of steers from the mountain region in Colorado took the first prize at the Chicago International Stock Exposition. A car load of stock from North Park was one of the successful winners, and last December the prize car load of fat steers were stock which had been raised by B. B. Brooks of Casper.

The lamb feeding industry has become one of the most remunerative occupations of farmers in alfalfa regions. A year ago 2,500 lambs which had been fitted for market at an altitude considered too high for alfalfa, but which were fattened on field pease, topped the market in the East. This fact opens great possibilities for the Laramie Plains, where we have demonstrated the possibility of raising large crops of field pease. This season we have planned an experiment in lamb feeding to compare our alfalfa and grain with a simple ration of field pease. Twenty-five acres of pease have been planted, and, nothing happening to destroy the crop, we hope to feed five hundred head of lambs this fall and winter. Such an experiment will be upon a large enough scale to show what can be done in a practical way, and the number will be sufficient to enable us to ship a car load of lambs to market to be sold in competition with those from else-

where. I have not asked for a special appropriation for this experiment, but will desire to use from any money available the amount necessary, the same to be returned to the fund when the sheep are sold. If this is not feasible at the time, we will be able to get the lambs in co-operation, or to buy them on sufficient time. Even should an accidental loss of sheep occur, the experiment will not be a very expensive one.

EQUIPMENT.—The things indicated, I believe we are now in a position to do on a larger scale than the Board will be able to provide funds to carry out. Our old Experiment Station farm consists of 120 acres of land fenced and improved. About one-half of this land is seeded to alfalfa. The penitentiary farm consists of 320 acres. Some of this land has been affected by seepage, which has brought up the alkali and made it of little use, but I believe all of it can be reclaimed by proper drain ditches to intercept the seepage water. Some of the land is rough and will require grading before it can be seeded to alfalfa or used for other crops, but bringing every acre of it into production will simply be a matter of a few years of proper management, cultivation and labor. Here at the penitentiary is a battery of buildings which, with comparatively small amount of expense, can be remodeled to make them suitable for any kind of stock work.

IMPROVEMENTS NECESSARY.—It will be necessary to so change a few of the buildings as to convert them into stables, feed rooms and dairy rooms, and to build fences, which will set aside pasture and protect the cultivated land, and make suitable yards to keep the several kinds of stock separate. I believe it a mistake to put expensive animals up against cheap barb wire fences. Fine stock should be confined, either with board fence, or woven wire, and, as fast as possible, it will be necessary to build such inclosures.

FUNDS NECESSARY.—With my report to the President, on the work of the past year, is an estimate of the funds deemed

necessary to carry on the department the ensuing year. I believe this Board appreciates the fact that equipping a farm with live stock is expensive if you deal only with the best, and it is my belief that, as an institution, we can afford to do nothing except with the very best examples of the breeds obtainable. Because of the need of large funds for this work, I do not expect to recommend that you appropriate any given amount, but if we are to begin the work on the new farm in a way which will induce the next Legislature to permanently turn it over to us, every dollar which can be spared for this purpose should be appropriated. So far as the Station is concerned, I think it should be the new policy to put our energies on the different phases of live stock work. The Station funds alone, however, are not sufficient for the work, but live stock is a legitimate equipment in the Agricultural College for teaching and breeding, and there is no fund coming to the University which cannot be used for this purpose, providing it is not necessary to use it for other things. While I do not state any amount with which to purchase stock, the expense which I deem necessary to begin the work, outside of direct purchase of animals, is covered in the following items:

HERDSMAN.—It is useless to obtain stock unless we can give them proper care and attention. It is impossible for the foreman of the farm to properly handle, feed and care for even a small amount of blooded stock. It will, therefore, be necessary to employ a herdsman, whose sole duty will be the handling and feeding of the live stock under my direction. I can obtain such a man for about fifty dollars a month, which will need an appropriation for the year of six hundred dollars.

REPAIRS AND FENCES.—The house should be papered, the woodwork painted, the grout walls repaired in places with cement, and the water connections changed from the union with tank in the penitentiary building to direct connection with the

city water pipe. I have not been able to get an estimate of this expense, but it may reach the sum of $100.00.

Perhaps the necessary remodeling of buildings and yards for the next year could be done at a total expense of not to exceed $100.00. All that could be saved on the estimates and all additional money which can be made available should be used for the purchase of stock. After we get our stock equipment, a very few years should enable us to make it self-supporting.

THE DIRECTOR'S POSITION.—The building up of this work means a large expenditure of energy and labor, as well as money. Your Director and Agriculturist, with the Executive Committee as his advisory board, should be given *carte blanc* in the use of funds, and in the decision about what to do and when, within the limit of the purposes for which the money is set aside, and the amount of the appropriation. There should be no curtailments or handicaps, except the one condition that the funds be economically and carefully used for the purpose in view.

In the matter of Station organization, I would refer you to the powers and duties of Station Directors, as outlined by Dr. True, the Director of Experiment Stations in Washington, as our highest authority on the handling of the station funds and affairs.

Publications.

During the past fiscal year we have published five regular bulletins, as follows:

INDEX BULLETIN C, JULY, 1902, BY G. R. HEBARD, SECRETARY.—This is a 34-page bulletin, indexing bulletins thirty-eight to fifty-three, from September, 1898, to June, 1902. It contains lists of the bulletins and reports of this Station; the monographs not issued in bulletin form, the press bulletins, and alphabetical list of bulletins with subject index of those issued

since Index Bulletin B was published. This follows Index Bulletins A and B, and completes the index of the Wyoming Station literature up to the end of the last fiscal year.

BULLETIN NO. 54, JULY, 1902, THE SHRUBS OF WYOMING, BY ELIAS NELSON.—This bulletin contains popular descriptions of 105 native shrubs of the State, with notes as to their occurrence and the natural conditions under which they grow.

In the introduction the preservation of native growths of shrubbery is urged, since they largely supplement the influences of forests in the regulation of the water supply. Their value as windbreaks for orchards and fields of agricultural crops and as shelter for stock in winter is also noted. Attention is called to the occurrence in our hills and along streams of many shrubs, which are attractive and desirable as ornamentals, and their more general planting for home decoration is recommended. Mention is made of some native fruits which may well be transplanted to the garden, and the improvement of certain wild berries is thought desirable.

The bulletin has forty-one pages of text, and contains five full-page cuts and ten text figures. Indices are given of both the Latin and common names.

BULLETIN NO. 55, OCTOBER, 1902, THE BIRDS OF WYOMING, BY WILBUR C. KNIGHT.—This bulletin was completed a short time before Christmas. It is a pamphlet of 174 pages, 48 half tones and 12 zinc etchings. It comprises a partial bibliography of the Wyoming literature, an article on bird study, one on birds and their relation to agriculture, and a list with notes of all of the birds known in the State up to the date of publication. There are 288 species or varieties enumerated. At the close there is an addenda and as a supplement the laws of Wyoming relating to birds. A large amount of data included in the bulletin was collected especially for it, and a collection of about 500 bird skins was made.

BULLETIN NO. 56, FEBRUARY, 1903, FOOD ADULTERATION IN WYOMING, BY E. E. SLOSSON.—This bulletin of 34 pages contains introductory articles on the extent and character of food adulteration in Wyoming and other mountain states; a brief discussion on the use of preservative and artificial colors; analyses of the following foods purchased in Wyoming: spices, tea, coffee, starch, oysters, jams and jellies, canned vegetables, vinegar and alcoholic liquors. The full text of the Pure Food Law passed by the last Wyoming Legislature is included in the bulletin.

BULLETIN NO. 57, MARCH, 1903, SHADE TREE SUGGESTIONS, BY AVEN NELSON.—This bulletin is the second in a series from the botanical department that has for its object the stimulation of those efforts in home making which tend toward permanency, and toward the production of home surroundings which shall yield pleasure and contentment. Those who are familiar with Wyoming conditions will appreciate both the needs and the difficulties that are discussed. Among the topics considered are (a) Available trees; (b) Wild vs. nursery grown stock; (c) Time to plant; (d) Cutting back; (e) Topping; (f) Methods of planting; (g) Irrigation; (h) Protection, etc.

The bulletin is illustrated by ten half-tones showing graphically some of the points made in the text, and none more clearly than the disastrous effects of "topping" when practiced under the climatic conditions that exist in Wyoming.

BULLETIN NO. 58, APRIL, 1903, GROWING AND PREPARING AGRICULTURAL CROPS FOR EXHIBITION, BY THE DIRECTOR AND THE BOTANIST.—This is a popular bulletin issued to meet an urgent demand in the State at the time for such information. The material is not compiled but is the result of our experience and work with exhibition crops. Wyoming agriculture is so new and our ranch population is so scattered, that the holding of agricultural fairs has not become general. A good evidence of our agricultural

growth is the formation of several fair organizations to hold fairs the coming fall. The State Industrial Convention will also make a general exhibit at Sheridan in October and the State Louisiana Purchase Exposition Commission is gathering material for St. Louis next year. The bulletin contains twelve pages and gives brief instructions for growing and preparing grains, grasses, vegetables and fruits in such manner as to most creditably represent the agricultural resources of the State at these shows. It is conveniently paragraphed for reference and use.

The following is the full text of the five Press Bulletins published during the year:

New Series—No. 12.

STORAGE RESERVOIRS FOR WYOMING.

A matter of much interest to Wyoming citizens just at present is what will be Wyoming's share of the benefits to be derived from the working of the irrigation law recently passed. The opinion has been advanced that favoritism or political influence would largely determine the selection of reservoir sites and the expenditure of the funds now available for the construction of storage works. This is diametrically opposed to the policy of the Interior Department. Mr. F. H. Newell of the Geological Survey, to whom has been given direction of the work under the new reclamation act, stated in a recent address that every project will be judged strictly upon its merits, that is, those projects which are the most feasible from an engineering point of view, which will extend the greatest good to the greatest number and which most surely promise returns upon the amount invested are those which will receive first consideration.

In deciding upon the projects to be undertaken little attention will be paid to state lines. If circumstances warrant, the entire sum which has been appropriated for inaugurating

operations under the new law will be spent in one state as provided for in Sec. 9, of the Irrigation Act. And this brings us to the point to which we wish to direct the attention of Wyoming farmers and business men. It is that the **amount of work** to be undertaken in Wyoming **depends largely upon** the interest which our **citizens manifest in the** matter and the energy **with which they advance** their claims.

There are dozens of resevoir sites in the state which undoubtedly would, if reservoirs were constructed, prove to be praiseworthy and profitable undertakings. Many of these reservoirs would reclaim land never before under cultivation. Others besides reclaiming new land would render more sure the water supply for lands already under irrigation. Reservoirs on streams already used for irrigation are those which necessarily most interest many of our citizens who own ranches upon and have vested rights in the waters of such streams.

Mr. Newell in his address stated that upon streams where the waters were already appropriated, that the appropriators if desirous of having a reservoir built would have to bear a proportionate share of the expense. This is in harmony with the spirit of the law, which requires that the irrigation works which the government constructs shall return their cost to the treasury and shall be self-sustaining. In other words if the government undertakes the construction of a work which will reclaim an area of land over and above that already under irrigation, the funds derived from the sale of these newly reclaimed lands shall be deducted from the total cost of the enterprise and the remainder must be paid by those persons having property along the stream who are directly benefited by the storage works. This sum is payable in ten yearly installments without interest. A prerequisite next to the feasibility of the work is that there shall be no complications of any sort which would interfere with the proper use of the water which may be stored or conveyed by the works constructed. Our State law admirably provides for, and in the majority of cases has effected a settlement

of all such disputes and complications as may arise between appropriators in the State itself, so that one condition which threatens to delay action in other states is happily absent in our own. Because of the unstable and insecure condition of water rights in Utah and elsewhere the government requires that the people to be benefited relinquish their rights to the government, which undertakes to exchange for the old rights new ones guaranteeing the original owners as much or more water than they had before. The rights of Wyoming appropriators are appurtenant to the land irrigated and are determined by the beneficial use to which the water is put. The irrigation law provides that rights to stored water shall be established upon a similar basis. Persons therefore in our State at least will not, it is thought, need to relinquish their rights in the waters involved as a condition precedent to the government undertaking the construction of storage works.

Ranchmen situated upon some stream the waters of which may be conserved and rendered more useful, should get together, settle any differences which they may have as to their respective rights and submit a petition to the Interior Department through the Geological Survey. This petition should set forth the size and exact location of the proposed reservoir, the amount of land at present irrigated with the probable area capable of reclamation, the usual and spring flow of the stream or streams by which the reservoir will be supplied and such other facts and data as will show the feasibility of, the necessities for, and the advantages to be derived from the proposed work. This petition will be taken up by the Interior Department, the project presented will be carefully examined by government engineers and a report and such recommendations as are warranted will be sent to the Secretary of the Interior through Charles T. Wolcott, director of the Geological Survey. A separate report will also be made by a reputable engineer. The proposition will then be passed upon by the Interior Department, and if found worthy will receive the approval of the

Secretary of the Interior and the necessary money will be appropriated.

Of course before any proposition would be considered the government would have to be assured of the good faith of the persons to be benefited. As has been stated, the government simply advances the money to construct the works, where the same are too large for private enterprise, and the parties benefited will then be expected to return the amount expended in ten yearly payments without interest.

Wyoming offers as wide a field for the operation of the irrigation law as does any state in the West. Our water rights are in a more stable and satisfactory condition than in any other Western state without exception, our agricultural possibilities are certainly as great and our people just as progressive. We are therefore justly entitled to a generous share of the work to be done under the Irrigation act. As stated above, our getting this share depends largely upon the interest and activity of the citizens of the State.

BURTON P. FLEMING,
Assistant in Irrigation,
Wyoming Experiment Station.

August 11, 1902.

Press Bulletin No. 13.

[These press bulletins are intended to give a brief and popular summary of the investigations reported in detail in the experiment station bulletins, and the papers of the State are requested to publish them as fully as possible.]

FOOD ADULTERATION IN WYOMING.

The question of food adulteration is of special importance in Wyoming, for we have to depend on other states for a large part of our food supply. Much of the food for miners, herders and ranchmen must be preserved in some way for convenience of storage and transportation, and most of our towns have extensive suburbs of tin cans. The prevailing use of foods in pack-

ages and cans, while it prevents personal close supervision for purity and cleanliness, which is easy where the markets are supplied from the immediate neighborhood, will at the same time make the general supervision and control of food products easier than elsewhere.

The prices paid in Wyoming for foods are high, and most employers pride themselves on sending out the best foods in the market to their herders or gangs of working men. Unfortunately the results do not often match their good intentions, for it is assumed that the highest priced, most extravagantly advertised and brightest colored food products are the best, and this is by no means the case. Some of the firms which are most vociferous in talking of "pure foods" and in warning against "imitations" are really responsible for the worst goods on the market. We all enjoy reading the attractively written and handsomely illustrated advertisements which load down the magazines, and we have a right to, for we pay for them when we buy the wares. A manufacturer sometimes sends out part of his product at a high price under a name which by expensive advertising has become a household word, and puts the same quality of food on the market without his trademark for sale at a much cheaper rate. The price of food products affords almost no indication of their purity or real value.

The most expensive foods are most extensively adulterated. Almost all the jellies on the market put up in glass tumblers are fraudulent, being composed of glucose, starch paste, and perhaps a little of the fruit, colored with coal tar dye and preserved with salicylic acid, this mixture being sold at 30 to 50 cents a pound. These are not poisonous, probably, in the amount that would be eaten, but since they are sold for pure fruit jellies, they run the genuine article out of the market. Preserves and jams are nearly as bad. Vinegar is very rarely cider vinegar, but is manufactured from the product of the distillation of wood and is usually below strength. It is almost impossible to get a sample of ground spice of any kind which

is pure. Cocoanut shells, flour and such stuff make up the bulk of these, and at the price of say 60 cents a pound, this is a profitable way of disposing of the dust of the flour bins. Whiskey and brandy, even when procured from reputable drug stores or distilleries, often contain wood alcohol, which is extremely poisonous, in place of the ordinary alcohol, which is bad enough in itself. There have been several deaths in the State from the substitution of wood alcohol for grain alcohol. Fresh oysters and other perishable materials are often preserved with formaldehyde, which, in any considerable quantity, is a violent poison. Beer frequently contains salicylic acid as a preservative, and the same preservative is added to many canned goods, especially to corn. Salicylic acid is a remedy for rheumatism, but all the people in the State do not have rheumatism, and, therefore, should not be continuously dosed without their knowledge.

Pepper is sometimes more than half peas. Butter is often preserved with borax and boric acid. The dried or evaporated fruits sold in the State have in some cases had all their juices soaked out before packing. We buy coffee extract without coffee, and lemon extract with no lemon in it. Maple syrup is often brown sugar or glucose syrup flavored with a decoction of hickory bark. Olive oil is made from cottonseed. Sausages—I do not know what they are made of, but they are sometimes colored with the same aniline dye we use for red ink.

Out of ninety samples of food recently analyzed in my laboratory, forty were adulterated.

I have not examined many drugs, but it is probable that the substitution of inferior materials is quite common, and this is especially objectionable since it is important that physicians should know exactly what they are prescribing.

Since Wyoming has no adequate pure food law, and no person who is authorized to prevent the sale of fraudulent or unwholesome foods and drinks, the only thing that can be done now is to publish, for the information of the people, the results of such chemical analyses as we have time to make. This, how-

ever, is only of benefit to the few who take the trouble to read and remember the facts given in our bulletins, and those who have not time or opportunity to look up the subject are the people who can least afford to be cheated in the quality or quantity of the food they buy. Almost all the other states have stringent pure food laws, and, naturally, until we are likewise protected, dealers will continue to unload into Wyoming the stuff they cannot sell elsewhere.

Citizens of the State are invited to send to the Station Chemist any samples of food or drink which are suspected of adulteration, and these will be analyzed, free of charge, whenever time can be found to do it. All such samples must be in unopened packages and full information given as to date, price and place of purchase. Names of local dealers will not be at present published, because, since there are no State regulations on the subject, they are in most cases ignorant of the composition of what they sell and innocent of any intention to defraud. A copy of the next bulletin on foods, to be published soon by the Station, and containing all analyses of food and drinks to date, with the names of the manufacturers, will be sent free to anyone asking for it.

E. E. Slosson, Chemist,
Wyoming Agricultural Experiment Station.

Laramie, Wyo., February 7, 1903.

Press Bulletin No. 14.

[The papers of the State are requested to print these Press Bulletins whenever possible.]

To the Grocers, Druggists and Saloonkeepers of Wyoming:

The last Legislature passed a stringent law prohibiting the adulteration and misbranding of foods, drugs and drinks, and the professor of chemistry of the University of Wyoming has been made State Chemist to carry out the provisions of the act. The attention of all concerned is therefore called to the necessity of informing themselves of the new requirement, in order that

by the time it goes into effect, September 30, 1903, they may have no goods in stock which they could not legally sell. In buying goods hereafter, all local dealers should protect themselves financially as far as possible by securing a written guarantee from the manufacturer that the articles are not adulterated within the meaning of the law and are properly labeled. A copy of the law is published by this Station in Bulletin No. 56, together with the report of such analyses of foods as have been made by the Station, and the bulletin will be sent to any address free of charge. The scope of the new law is indicated by the following extract:

"Sec. 6. No person or persons shall, within the State of Wyoming, manufacture for sale, offer for sale, or sell any drug or article of food or drink which is adulterated within the meaning of this act.

"Sec. 7. The term 'drug' as used in this act, shall include all medicines for internal or external use, antiseptics, disinfectants and cosmetics. The term 'food' as used in this act, shall include all articles used for food, whether simple, mixed or compound, the term 'drinks' shall include all drinks, whether distilled, brewed, simple, mixed or compound, including mineral waters which shall be used as food, medicines or beverages by any person or persons while in the State of Wyoming, whether a citizen or not.

"Sec. 8. An article shall be deemed to be adulterated within the meaning of this act: (a) In case of drugs: (1) If, when sold under or by the name recognized in the United States Pharmacopoeia, it differs from the standard of strength, quality or purity laid down therein; (2) if, when sold under or by the name not recognized in the United States Pharmacopoeia, but which may be found in some other pharmacopoeia, or other standard work on materia medica, it differs materially from the standard of strength, quality or purity laid down in such work; (3) if its strength, quality or purity falls below the professed standard under which it is sold. (b) In case of food: If any

substance or substances have been mixed with it, so as to lower or depreciate, or injuriously affect its quality, strength or purity; (2) if any inferior or cheaper substance or substances have been substituted wholly or in part for it; (3) if any valuable or necessary constituent or ingredient has been wholly or in part subtracted from it; (4) if it is an imitation of or sold under the name of another article; (5) if it consists wholly or in part, of a diseased, decomposed, putrid, infected, tainted or rotten animal or vegetable substance or article, whether manufactured or not—or, in case of milk, if it is the produce of a diseased animal; (6) if it is colored, coated, polished or powdered, whereby damage or inferiority is concealed, or if by any means it is made to appear better or of greater value than it really is; (7) if it contains any added substance or ingredient which is poisonous or injurious to health; Provided, That the provisions of this act shall not apply to mixtures or compounds recognized as ordinary articles or ingredients of articles of food, if each and every package sold or offered for sale be distinctly labeled as mixtures or compounds, with the name and per cent. of each ingredient therein, and are not injurious to health."

Hitherto dealers in the State who wished to sell only pure foods, drinks and drugs have been at a disadvantage, for they have come into competition with others who were less scrupulous and could sell adulterated goods at lower price. Now, however, honest dealers are protected, and it is expected that they will be as much interested in the enforcement of the law as is the general public.

After October 1, 1903, any samples of food, drugs or drinks sent to me by the citizens of Wyoming will be tested for adulterants free of charge.

The law also regulates the sale of oil, and fixes the legal burning point for kerosene.

E. E. SLOSSON, Chemist,
Wyoming Agricultural Experiment Station.

Laramie, Wyo., March 1, 1903.

Press Bulletin No. 15.

HOW TO PREVENT SMUT IN GRAIN.

Smut in wheat and oats causes serious loss to Wyoming grain growers. Sometimes the loss amounts to two-thirds or three-fourths the entire crop, and in such instances the small amount of grain obtained has little market value. The trouble is easily overcome, and it is dollars in the pocket of every man who raises wheat or oats to treat his seed to prevent the disease. It costs from two cents to five cents per bushel, or from four cents to ten cents per acre, to treat the seed. Where the treatment is properly and carefully done the resulting crop may be increased in value from four dollars to eight or more dollars per acre.

Smut is caused by tiny black or brown spores which cling to the seed, or which may remain in the ground over winter. When the seed germinates the spores also grow, and send a minute thread up in the grain stalk to the head, where it destroys the kernels of grain, producing spores instead. Anything which will kill the spores on the seed without injuring the germination of the grain will improve the quantity and quality of the crop, providing the treated seed is planted on land which has not grown smutty grain for one or two years. We recommend any one of the following four methods:

1.—Jensen Hot Water Treatment.

This is generally recommended as the best method. You must have a good thermometer to test the temperatures. The water may be heated in any convenient way. Have the water in one barrel or tub at a temperature of 125° to 130° F., and in the second barrel at a temperature of 132½° to 133° F. Put the grain in a wire basket or gunny sack, having it only partly full, so the grain can be all shaken apart when in the water. Dip into the first barrel for three or four minutes to thoroughly warm it. Then dip it at once into the second barrel, subjecting the grain to the temperature of 132½° to 133° for ten minutes,

shaking about so all the grain will become warmed to the temperature of the hot water. Lift out of water, drain and spread out to dry before sowing. Be very careful with the temperature of the water. If it goes above 134° or 135° the grain will be injured, and if the seed treated is not heated to 132° the spores will not be killed. Do not leave in the water more than ten minutes. Have eight or ten times as much water as the amount of grain dipped at a time and have hot and cold water at hand to add, in order to keep proper temperature while grain is being dipped. [Send for Wyo. Exp. Sta. Bull. 21.]

2.—Copper Sulphate or Blue Stone.

a.—Dissolve one pound copper sulphate in 5 gal. water by hanging a sack containing it in the top of a barrel or tub until the sulphate is all dissolved. Dip the grain in this solution for two or three hours and then spread out to dry.

b.—A safer method.—Dissolve one pound copper sulphate in 20 gal. water and let grain soak 12 hours. Then dip in solution of one pound lime to 10 gal. water for five or ten minutes and spread out to dry.

3.—Potassium Sulphide for Oats.

a.—Dissolve 2 pounds potassium sulphide in 20 gal. water and soak seed 10 or 12 hours. Then dry so the oats can be planted with drill or otherwise.

b.—Dissolve 1 pound potassium sulphide in 20 gal. water and soak the oats 24 hours, and dry. This is an excellent method.

4.—Formalin for Wheat or Oats.

a.—Pile the grain on a floor where it can be shoveled over or stirred. Mix one pound of Formalin (Formaldehyde) in 50 gal. water and sprinkle over the grain with a hand or garden sprinkler, stirring the grain until it is all wet.

b.—Mix one pound of formalin with 100 gal. water and dip the grain in it until it is thoroughly saturated. Spread out to dry or plant at once. Formalin must be used with great care

for if used in too strong solution or the grain left in too long it will destroy its germinating power.

General Caution.

In our experiments we have found that the germinating power of seed wheat or oats raised at high altitudes is quite easily injured. In treating it more than ordinary care must be taken. In using above methods with grain raised above 6,500 feet altitude, be sure that the water does not get too hot, and do not soak more than eight or ten minutes. With other treatments, use the weaker solutions, and do not soak the seed more than twelve to twenty hours.

B. C. BUFFUM, Agriculturist,
Wyoming Agricultural Experiment Station.
Laramie, Wyo., March 20, 1903.

Press Bulletin No. 16.

POTATO DISEASE AND TREATMENT OF SEED.

There can be no doubt that the success of the potato crop depends very much on the condition of the seed. The time for planting is near at hand, and we wish to call attention to potato troubles which may be avoided to some extent by treating the seed. Our experiments indicate that such treatment, if carefully done, will prove highly profitable. The average grower does not realize as great profit from his potatoes as he might. There are too many failures; too many instances of only partial crops, and too many potatoes put on the market which are scabby or otherwise imperfect.

About two years ago Prof. F. M. Rolfs of the Colorado Experiment Station discovered the cause of many of our potato failures, and his study since that time has been of great value to the potato grower. The troubles which are often called "blight," "collar" or "crown rot," "black ring," and "little potatoes," are due to a disease which is caused by a fungus, known as RHYZOCTONIA. This fungus grows on a dozen or more dif-

ferent kinds of plants, and does serious injury to several of our more important agricultural crops. It was first discovered on alfalfa and clover roots in Europe nearly ninety years ago, but the first account of its appearance in this country was published by the Cornell and Geneva Experiment Stations in 1901. So serious is the pest on potatoes in the West, that it not only decreases the potato crop thousands of dollars' worth every year, but over large areas farmers make few attempts to raise potatoes at all, under the impression that their soil is such that it is impossible to grow profitable crops.

In our potato regions it is necessary to change seed every two or three years, in order to get that which is more free from the disease or more able to resist its attack. Two years ago potato crops failed generally over a large portion of the West. The cause was not apparent, but it is now believed that the season was especially favorable to the growth of this fungus.

The fungus grows on the potatoes themselves, producing rough, cracked, corky skins, but the principal damage is done by its attack on the young sprouts. It either kills them before they come up, causing poor stands of plants, or affects the growing vine in such a manner that the root-stalks, upon which the young potatoes set, are either cut off or the vine is deprived of nourishment, so the tubers which do set on, remain small. The effect on the vines is often called "blight." The fungus remains over winter in the soil, and also on the potatoes themselves, where it is easily seen in the brown or black spots which look like particles of soil, and these are difficult to remove, but when rubbed open they look something like smut of the wheat kernel.

REMEDY.—If potatoes are grown on soil which has become affected with the fungus, little can be done, though Rolfs found that after the vines showed "blight," spraying with Bordeaux mixture increased the crop. It is believed that the fungus will live at least three years in the soil, and be ready to produce the disease on potatoes planted therein, so it is important that the

crop be grown on clean land. It is well to follow grain crops, upon which this fungus does not work, with potatoes in rotation. If the seed is free from disease, alfalfa land is used with apparent success. Good crops can be produced by selecting those tubers which do not show the disease, but our seed is so completely affected that this is difficult to do, and could not be practiced by those who do not know what to look for. The dark spots (sclerotia) carry the fungus through the winter, on the potato tubers, and anything which will destroy their life will help the seed. It has been found that drying out in the bright sunshine accomplishes this purpose quite effectively, and thoroughly sunning the potatoes for a few days before they are cut is good treatment. Sunshine does not reach the fungus in deep eyes or scab pits, and to make the treatment thorough, the potatoes, before being cut, are dipped in a solution of corrosive sublimate.

Dissolve two ounces of corrosive sublimate in two gallons of hot water, and mix this with fourteen gallons of water in a barrel. This gives a solution containing one ounce of corrosive sublimate in eight gallons of water. Soak the potatoes in this solution for one and one-half hours, after which spread out in the sun to dry before they are cut for seed.

This treatment not only kills the RHYZOCTONIA fungus, but it also destroys the fungus which produces potato scab and protects the seed potatoes from rotting in the soil, should sprouting be delayed by long continued wet or cold weather.

In the experiments of the Wyoming Station, we found that treating the seed with corrosive sublimate greatly increased our crop. Care must be taken in using this treatment, because corrosive sublimate is a deadly poison. It must be used in wooden or earthenware vessels, and these, or the sacks in which the potatoes are placed, must not be used for any other purpose. The solution must not be too strong, nor the potatoes soaked longer than the time stated, because it is apt to kill the potato sprouts, or make them very slow to come up.

After soaking the seed, it should be treated with sunshine for a few days, and cut not more than a day or two before planting. Our best results have been obtained by planting small potatoes whole, or by quartering the potato lengthwise, leaving a part of the seed-end on each piece. Plant a liberal amount of seed.

There are a few copies of Bulletins Nos. 26 and 32 of the Wyoming Experiment Station on potatoes. These can be obtained by addressing the Director at Laramie. Those interested may be able to obtain Bulletin No. 70 of the Colorado Station by requesting same of the Director at Fort Collins.

B. C. BUFFUM,

Director Experiment Station, Laramie, Wyo.

April 28, 1903.

Financial Report of the Treasurer.

UNIVERSITY OF WYOMING,
Agricultural Experiment Station,
In Account With
The United States Appropriation, 1902-1903.

DR.

To receipts from the Treasurer of the United States, as per appropriation for fiscal year ending June 30, 1903, as per act of Congress approved March 2, 1887		$15,000.00

CR.

By Salaries	$ 6,085.60	
Labor	3,120.03	
Publications	1,494.52	
Postage and stationery	507.44	
Freight and express	224.40	
Heat, light and water	708.94	
Chemical supplies	223.42	
Seeds, plants and sundry supplies	596.86	
Fertilizers	5.15	
Feeding stuffs	209.37	
Library	2.15	
Tools, machinery and implements	218.80	
Furniture and fixtures	338.27	
Scientific apparatus	76.60	
Live stock	192.03	
Traveling expenses	233.37	
Contingent expenses	13.05	
Building and repairs	750.00	
Total	$15,000.00	$15,000.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1903; that we have found the same well kept and classified as above, and

that the receipts for the year from the Treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

[Signed] A. C. JONES,
H. L. STEVENS,
Auditors.

Attest:
GRACE RAYMOND HEBARD,
Custodian.

SUPPLEMENTARY STATEMENT.

DR.

	Farm. Products.	Fees.	Individuals.	Total.
To receipts from other sources than the United States for the year ending June 30, 1903.....	$385.10	$220.39	$120.00	$725.49

CR.

Buildings and repairs.............................	$641.49	
Contingent	84.00	—$725.49

Report of the Agriculturist and Horticulturist.

My predecessor, Professor F. E. Emery, turned the work over on September first. The season's work on the Experiment Farm as planned by him had been practically finished, with the exception of harvesting the crops, which was done under my supervision. The season had been unusually cold and dry, but a good supply of alfalfa hay had been put up, and fairly good crops of potatoes and grain were secured. The earlier varieties of grain which ripened were as plump and heavy as usual, the most of them being heavier than the standard weights, and one variety of wheat weighed over 65 pounds per bushel.

This season, for the first time since the Station was established, every acre of land on the farm which is suitable for crop production has been planted to some kind of crop. We have broken up twenty acres of sod land and planted it to pease. These and some pease on old land will be used in an experiment in feeding lambs by letting them harvest both their grain and roughage in the field, and comparing the lot so fed with a lot fed alfalfa and grain in the usual manner.

LIVE STOCK.—Upon taking charge of the department I found two Shorthorn cows with calves by their sides, and three Hereford cows, each of which dropped a calf during the year. On December 31 one of the Hereford cows, "Beulah," died of anthrax. The calf dropped by the other Hereford heifer also died. One of the Shorthorn calves is not eligible to registry, as there is no accurate record of her breeding. The other Shorthorn calf is a bull of unusual individual merit and breeding, registered as "Larimbar" 205334. Application has been made for the registration of two Hereford heifer calves. In January the young stock on the farm was vaccinated for blackleg, using the double blackleg vaccine from the Pasteur Institute. There is on hand a flock of nine Rambouillet Merino sheep and about

a dozen turkeys. We have added to the poultry equipment by the purchase of a Cyphers incubator of 120 egg capacity and a brooder. One hatch has been made, in which we obtained about fifty per cent. of chicks from the fertile eggs. The general work of this department is fully outlined in the report of the Director.

PLANS FOR 1903.

AGRICULTURE—INCLUDING ANIMAL INDUSTRY.

1. *Cropping and Soils.*

a.—Field pease—Test of varieties.

b.—Field pease—For stock food (25 acres).

c.—Additional seeding and high altitude studies of alfalfa.

d.—Grains—Wheat, oats, barley, speltz for seed and feed.

e.—Grains raised for exhibition.

f.—Mixed grasses for seeding permanent meadows—Co-operation with ranchmen.

g.—General crops—Potatoes in irrigation work—Fertilizers, etc.

h.—Co-operation with U. S. Department of Agriculture with sugar beets and soil work.

2. *Animal Industry.*

a.—Feeding lambs—Pease vs. alfalfa and grains.

b.—Gathering data and photographs of the ranch and range stock business of the State.

c.—Management of breeding herds.

d.—Poultry experiments (turkeys and chickens).

e.—Digestion experiments—Investigation of stock foods in co-operation with the Chemist.

HORTICULTURE AND AGROSTOLOGY.

1. *Fruits.*

a.—Orchard fruits at Lander.

b.—Co-operation in a small way with one or two ranchmen.

c.—Small fruits.

d.—Photographs, casts and other additional data.

2. *Vegetables.*

a.—Trials of novelties suited to high altitudes.

3. *Flowers.*

a.—For decoration.

4. *Grasses and Forage Plants.*

a.—Co-operation with U. S. Department of Agriculture, division of agrostology.

b.—Drouth resistant pasture grasses.

c.—Co-operation with one or more ranchmen in making permanent hay meadows. (Agriculture I.—f.)

d.—Varieties of grasses and forage plants in plats on the station farm.

e.—Digestion experiments with those forage plants which have been found adapted to our high altitude agriculture. (Agriculture II.—e.)

f.—Cultural treatment of native pasture or range to improve forage.

IRRIGATION.

1. *Duty of Water.*

a.—Amount of water to produce maximum crop—With potatoes and oats.

b.—Measurement of amounts used on all crops.

2. *Seepage and Evaporation.*

a.—Such investigations of return waters and that lost by evaporation as our funds and help will permit, either in co-operation or carried on by ourselves in connection with other research.

3. *Co-operation.*

a.—With Hydrographic Survey, U. S. G. S.—Measurements on Little Laramie river.

b.—With office of Irrigation Investigations, U. S. Department of Agriculture.

B. C. Buffum,
Professor of Agriculture and Horticulture.

Report of Botanist.

The year just closing has been one of the busy ones in which little that is apparent to the public can be pointed out. Each year, of course, has it routine duties of conference and correspondence. More and more these consume time, but in that proportion they bring the work of the Station into personal relation to the people.

The lines of work indicated in the last report have each had some attention. Foremost among these are the—

FORAGE PROBLEMS.—In the solution of these no great advance is possible in any given year, but results will finally be attained by a campaign of education. It needs to be said again and again that while something may be expected from the introduction of *new* forage crops, yet our greatest hope lies in more rational treatment of the resources at hand and in an increased use of the *long-known* field crops. This lesson is learned but slowly by the ranchman who has come to think that the vast plains should forever yield their increase without care, or who, finding that they do not, thinks nothing worth while unless great results on great areas may be shown at once. An attempt to make clear that great results, *in the aggregate,* are attained by attention to details was made in an extended paper entitled "Some Methods for the Improvement of Wyoming's Meadows," read before the Industrial Convention, at Cheyenne, in February.

HOME MAKING.—Under this title some studies are under way that seem particularly timely in this new State. No suggestions have a kindlier reception than those looking to the permanency of the home, and its improvement as such, by making the surroundings pleasant and refining. A series of illustrated bulletins is contemplated which shall emphasize the need

of home making in the best sense. The first of these, entitled "Native Vines in Wyoming Homes," was issued last year; the second, called "Shade Tree Suggestions," this year.

Attention, in a more public way, was called to the heretofore transient character of the home improvements by an illustrated paper entitled "Some Peculiar Needs of New States," read at the annual meeting, in October, of the Association of Agricultural Colleges and Experiment Stations, at Atlanta, Ga. The paper was published in the proceedings.

FUNGI.—The work contemplated in this line, and of which there is much need, has not yet reached completion. There is room for some valuable research work, but we need to issue one or two "information bulletins" first of all.

NATIVE FLORA.—The vegetation of the State is still being studied in the field and in the herbarium. The relative abundance and the distribution of the more important economic species is now fairly well known. A few papers dealing with technical phases of our flora have been published in the botanical journals.

AVEN NELSON,
Professor of Botany.

Report of the Chemist.

Besides the usual routine analyses and correspondence, the time of the Chemist during the year has been chiefly occupied with analyses of the food products sold in Wyoming, the results of which have been published in Bulletin No. 56. Two Press Bulletins on the same subject, Nos. 12 and 14, have been written. As a result of this work, the last Legislature passed a Pure Food Law and made the Chemist of the Station, State Chemist in charge of the investigations necessary to its enforcement. An assistant is also provided by the State to

carry on part of the analytical work. Since so large a part of the food supply of Wyoming is imported and much of it has to be in a portable and non-perishable form, there is a great temptation to use preservatives in considerable quantities and inferior goods are frequently sold at high prices.

In addition to the continuation of the work on the adulteration of food, it is proposed during the coming year to study the composition and digestibility of the native grasses and forage plants of the arid region.

A convenient room in the new Science Hall has been fitted up as a Station laboratory, and much more work can be done by this department of the Station than before.

E. E. Slosson,
Professor of Chemistry.

Report of the Geologist.

Two lines of work were carried on during the year. First, wind erosion and its relation to soil making; second, the occurrence of alkali, its distribution geologically and possible methods to prevent further accumulations in the soils of the State.

Considerable work was done upon both of these topics; but not sufficient to warrant the publication of a bulletin. With the completion of the investigation of the coming year, I anticipate that there will be sufficient data to complete at least one short bulletin.

Wilbur C. Knight,
Professor of Geology.

Report of the Meteorologist and Physicist.

The work in meteorology has been a continuation of that of former years. Observations have been taken of the relative humidity, maximum and minimum temperatures, pressure of the air, rainfall, snowfall, velocity and direction of the wind, evaporation, percentage of sunshine, and the temperature of the soil at various depths. All observations, except the amount of rainfall and snowfall, are taken each day at 7 a. m. and 7 p. m.

I hope to continue investigations upon the physical characteristics of the soils of Wyoming during the coming year. During this summer I have been investigating the best methods for exterminating the greatest pest of our yards and meadows, the dandelion.

The following is the meteorological summary for the year 1902:

Highest temperature, August 1, 91 degrees.

Lowest temperature, January 26, —18 degrees.

Mean temperature for year, 41.6 degrees.

Greatest daily range of temperature, June 21 and September 9, 47 degrees.

Lowest daily range of temperature, October 5, 5 degrees.

Mean daily range of temperature, 25.7 degrees.

Mean soil temperature, 3 inches, 45.5 degrees; at 6 inches, 44.5 degrees; at 12 inches, 47.5 degrees; at 24 inches, 45.5 degrees; at 36 inches, 40.6 degrees; at 72 inches, 44.4 degrees.

Highest barometer, July 19, 23.533.

Lowest barometer, May 19, 22.432.

Mean barometer for year, 23.002.

Highest dew-point, August 24, 66 degrees.

Lowest dew-point, December 31, —42 degrees.

Mean dew-point for year, 26.3 degrees.

Highest relative humidity, February 19, March 20, April 14, September 21, November 1, 98 degrees.

Lowest relative humidity, June 18, 6 degrees.

Mean relative humidity for year, 58 degrees.

Evaporation from May 7 to November 1, 31.8 inches.

Greatest monthly evaporation in June, 7.48 inches.

Highest monthly precipitation, in September, 1.58 inches.

Lowest monthly precipitation, January, trace.

Greatest amount of precipitation during a single storm, September 20, 21 and 22, 1.30 inches.

Total precipitation for year, 7.65 inches.

Mean precipitation for 10 years, 8.95 inches.

Prevailing direction of wind, southwest.

Greatest velocity of wind per hour, September 29, 64 miles.

Total number of miles traveled by wind during year, 101,-675 miles.

Greatest number of miles traveled in one month, March, 10,791 miles.

Least number of miles traveled in one month, October, 6,920 miles.

Average number of miles traveled per month, 8,473 miles.

Greatest number of miles in one day, March 16, 542 miles.

Least number of miles traveled in one day, December 17, 54 miles.

Mean daily distance, 279 miles.

Mean hourly distance, 11.6 miles.

Number of clear days, 199.

Number of partly cloudy days, 113.

Number of cloudy days, 53.

Number of days on which .01 inch or more of precipitation fell, 51.

C. B. Ridgaway,
Professor of Physics and Meteorology.

Report of the Irrigation Engineer.

The principal work in the line of irrigation carried on during the past season by this office was that in which we co-operated with the office of Irrigation Investigations of the United States Department of Agriculture. This work was an investigation to determine as fully as possible the conditions prevailing in a district where irrigation practice is typical of that existing in Southern Wyoming at the present time. The locality selected for the investigation was that bordering upon and irrigated from Sand creek, a small stream tributary to the Laramie river.

The field work of the investigation included daily gagings during one year of the flow of the stream at two points in its course, one above and the other below the body of the irrigated land; daily gagings of the flow of ditches diverting water from the stream during the irrigation season; a series of measurements of the stream to determine seepage gains and losses, and the necessary surveys to determine capacity and practicability of possible reservoir sites. Besides the data secured by field work, considerable information was obtained from the State Engineer's office in regard to water rights, appropriations, etc., and from the records of the United States Land Office and the Albany County Clerk in regard to land titles. The report made to the office of Irrigation Investigations in March, 1903 covered 40 pages of typewritten matter, and aimed to give as completely as possible such results and conclusions as could be gained from one season's work. The problem most concerning the people of the district is that of interstate water rights. Sand creek is an interstate stream, its source and about half its length being in Colorado. In the portion of its length lying in Colorado diversions have recently been made by Colorado parties which seriously conflict with the rights of Wyoming appropriators whose lands lie along the lower reaches of the stream. This question was, therefore, given

prominence in the report, and it is thought that the facts determined by the season's work in regard to amount of water diverted, property losses, etc., together with photographs and maps, will be of no little value when the case is eventually brought into court.

The irrigation investigations on the Experiment Farm have been a continuation of the work long under way in the determination of the amounts of water actually used in the irrigation of various crops, according to the usual practice of the irrigator. In addition, work was carried out on a somewhat more extensive scale than hitherto in the determination of optimum amounts of water to be used in the irrigation of a particular crop. Potatoes was the crop experimented upon last season, with a view to checking results of the previous year. A substantial measuring weir was placed in the bank of the Pioneer canal adjacent to the plats to be experimented upon, and so arranged by means of excess weirs that it was possible to obtain a very uniform flow. Water was conveyed to the plats to be irrigated in V shaped wooden fluming, in which small canvas dams were placed at proper intervals, allowing water to be drawn out upon the plat through holes in the bottom of the flume. In operation, the weir was adjusted to give a constant flow, and the water was then allowed to flow out upon the plat for a certain definite time. In this way, and by draining the flume below a waste gate placed near the weir, after the irrigation of each successive plat, it is thought that the amount of water actually applied was a very close approximation to the desired amount. The amounts of water applied to the several plats varied from a minimum of 3 inches to a maximum of 36 inches. Two series of plats were used, upon one of which the total amount of water used was applied at one irrigation and upon the other series at different times during the season. The results showed that a depth of application of 9 inches of water by irrigation gave the largest yields, the plats irrigated twice giving the best results. It must be stated, however, that too

much care cannot be taken in drawing conclusions from such results. Numerous complications arise which cannot be foreseen, and whose effects are difficult of exact determination. The past season the potatoes yielded by the experiment were found to be badly infested with a fungus disease known as Rhysoctonia. This disease, in connection with the varying amounts of water used, may have had considerable influence in varying the yield. It is, therefore, proposed to check the past season's work during the coming season by an experiment under similar conditions, in which different land and imported seed will be used. Should the results of the previous two years be corroborated by those of this season, it is thought that a bulletin summarizing these results, together with other determinations of the duty of water, will be timely and of sufficient interest to warrant its publication.

The field work for the coming season, in addition to the work outlined above, will include a similar line of work upon oats and the usual measurements of amount of water used in actual practice will be continued. The co-operative work of this season with the office of Irrigation Investigations includes a rather extensive seepage survey of the Laramie and North Platte rivers, together with supplementary studies of the seepage gains or losses in representative canals along these rivers. This work will require considerable traveling, chiefly by boat, and will probably necessitate my absence from Laramie during a large part of the summer. The Station is also co-operating with the United States Geological Survey in gaging the Little Laramie river, a small stream a short distance from Laramie, which irrigates a considerable body of hay land. Records are being kept of the flow at a point well above the body of the irrigated land, and at another point a short distance above the mouth of the stream and below the irrigated land. It is hoped that some idea may be derived from these measurements as to the net use of water upon such a stream.

BURTON P. FLEMING,
Irrigation Engineer.

Report of Assistant in Horticulture and Agronomy.

Besides the regular work appertaining to horticulture and agrostology and other duties about the office, some work has been done for other departments of the Experiment Station. During October and November considerable time was spent with the Chemical Department, testing certain foods for adulterations and preservatives. For the Botanist determinations have been made of the grasses collected by him and his assistant during the season of 1902, and also of some other plants belonging to certain genera.

The cultivation of canaigre, the roots of which are grown extensively in New Mexico, Arizona and California for the tannin which they contain, has been tried at Laramie. Seeds and roots were secured in the spring of 1902 from the California Experiment Station, and planted respectively on April 29 and May 5 on a plat of ground below the greenhouse. The roots planted did not vegetate, but the seeds germinated, and the plants secured made a fair amount of growth during the season. Roots were also procured from the New Mexico Experiment Station, and these, planted on July 8, grew and increased considerably in size. Canaigre appears to be quite hardy here, as the plants lived and remained green until very late in the fall. Most of the roots were dug up and stored in a cellar over winter. These roots have been planted and are now well started into growth. The roots, which were allowed to remain in the soil, did not live through the winter.

HORTICULTURE.

Among other shrubs growing at the Experiment Farm, *Lonicera caerulea* and *Caragana pygmaea* deserve mention. The latter is a low, spreading shrub, which has yellow blossoms and flowers profusely in season. Both of these shrubs seem perfectly hardy at this altitude.

A native form of the flowering currant, valuable for its fruits, was established on the farm during the season. The plants were brought from the Platte canon by Professor Aven Nelson, who had located and marked the bushes in 1901. This currant has a yellow berry of fair size, and is highly valued for culinary purposes in districts where it grows. Since it appears to be a promising currant, it has been planted on the farm with a view to its domestication and improvement.

In the spring of 1901 and also in 1902 various native shrubs and trees were set out on the University grounds. Some of these were secured in the hills east of the city, but the greater part of them were brought from the Platte canon by Professor Aven Nelson. Others are from Granger or from Evanston. As a result of these plantings, the followng are now growing on the campus:

Salix amygdaloides,	Rosa Fendleri,
Salix Bebbiana,	Amelanchier alnifolia,
Salix lutea,	Crataegus rivularis,
Salix Nuttallii,	Prunus Americana,
Alnus tenuifolia,	Prunus demissa melanocarpa,
Ribes longiflorum,	Lepargyraea argentea,
Ribes saxosum,	Elaeagnus argentea,
Opulaster monogynus,	Fraxinus lanceolata,
Lonicera involucrata,	Crysothamnus sp.

In July a bulletin was published on the shrubs of Wyoming. It contains popular descriptions of all the shrubs known to grow without cultivation in the State.

In the greenhouse a general collection of plants has been kept and maintained throughout the year. Efforts have been put forth to have as large a variety of greenhouse plants as possible. Many plants have been grown from seed, while the stock of certain desirable ones has been increased through propagation from cuttings. It has been found necessary to fumigate quite frequently to kill plant lice and other insects which are

troublesome in the greenhouse. Both the stems and the fluid extract of tobacco have been used for fumigation, while whale oil soap dissolved in water has been serviceable as a spray.

Two varieties of tomatoes, seed of which were received *gratis* for trial from W. Altee Burpee & Co., have been grown in the greenhouse. They were started from seed sown March 25 and grown in pots until July 18, when they were set out into benches. Ten plants of each variety were planted 22 inches apart each way and trained to one stem. They remained in the benches until January 30. Special attention was given to the watering, as the leaf-curl disease, or oedema, is likely to appear when the soil is kept too moist. In spite of this precaution one of the varieties became badly affected.

Burpee's Quarter Century tomato came into bearing October 9, and continued to produce fruits until January 30. The total yield of the ten plants was 161 fruits, weighing 20 pounds and one ounce. This variety made a stocky growth, had well formed fruits and was only slightly affected by leaf-curl. Burpee's Large Early tomato was in bearing from October 18 to January 10. and yielded 189 fruits, weighing 15 pounds and 9 ounces. The plants became quite badly affected with leaf-curl, which greatly reduced the size of the fruits.

In February and March various bedding plants were sown in flats in the greenhouse. About 8,000 individual plants were grown during the spring months for planting on the University campus.

A number of flowering plants not grown before at Laramie are being tried this year. About 750 cabbage and cauliflower plants have been grown in the greenhouse for the Experiment Farm. Several varieties of onions were also started from seed in the greenhouse, and later set out on the farm.

Two thousand cottonwood cuttings and one thousand willow cuttings were stuck in sand in the greenhouse, and as soon as calloused and roots began to form were planted on a moist sandy plot of ground on the penitentiary farm.

About an acre has been put in this spring to vegetables. The seeds were secured mostly from W. Altee Burpee & Co. Besides new varieties planted for trial, standard varieties known to do well at this altitude are also being grown. Arrangements have been made with the horticulturist of the U. S. Department of Agriculture for co-operative work in the taking of notes on the tests of vegetables made on the farm this season.

AGROSTOLOGY—CO-OPERATIVE WORK WITH THE U. S. DEPARTMENT OF AGRICULTURE.

The work during the season of 1902 was as follows:

1. Observations on the growth of the various grasses and forage plants already established on acre plats 21, 16 and 9, and the recording of the notes taken.

2. Planting of additional grasses and forage plants for the purpose of observing their growth and of determining their value for this region.

3. Experiments in range improvement—sowing of various grasses and forage plants in the Station pasture.

4. Taking of notes on the forage condition of the range through the season and observations on the growth of grasses in the pasture.

5. Establishment of a permanent meadow by means of irrigation and the sowing of grass seed.

6. Gathering of seed of promising forage plants on the plats on the farm and elsewhere.

7. Experiments with salt bushes—

   a.—Fall versus spring planting.

   b.—Covering seeds versus surface planting.

   c.—Determination of the optimum depth of covering the seed.

   d.—Soaked seeds versus unsoaked seeds for planting.

   e.—Germination tests in the greenhouse.

   f.—Husked versus unhusked seeds for planting.

During the year two reports have been made to the U. S.

Department of Agriculture on the co-operative work, one on the work of the summer of 1902, the other on the spring operations of 1903.

THE GRASS PLATS.—In 1901 a stand was secured of nineteen grasses and two other perennial forage plants. One of the grasses, *Lolium perenne*, did not live through the following winter. The grasses and forage plants on permanent plats for study during the season were as follows:

Agropyron caninum,
Agropyron dasystachyum subvillosum,
Agropyron occidentale,
Agropyron richardsoni,
Agropyron spicatum,
Agropyron spicatum inerme,
Agropyron tenerum,
Bouteloua oligostachya,
Bromus inermis,
Bromus marginatus,
Bromus pumpellianus,
Bromus richardsoni pallidus,
Elymus canadensis,
Elymus glaucus,
Elymus virginicus submuticus,
Festuca pratensis,
Festuca rubra,
Stipa viridula,
Melilotus officinalis,
Poterium sanguisorba.

These plats were examined throughout the season at intervals of from seven to fifteen days and notes taken on their condition and the growth of the plants. The plants on acre plat 21 were irrigated on June 26 and 27, and those on acre plat 9 on July 15. They were kept clear of all weeds, and on July 14 each plat was examined, and all grasses not belonging on

each particular plat dug out. All grass in the walks and alleys between the plats were also removed. Seed was gathered on fourteen of the plats.

In the latter part of April the grasses started into growth, and by the 8th of May the leaves of the wheat, brome and rye grasses were from three to five or six inches long. The dry weather of May and June did not allow of much growth, and in June some of them exhibited signs of drying up. The irrigation which they received, together with some rain during July, made it possible for them to grow considerably and mature some seed. The amount of growth which they made was without doubt much smaller than that which would have been secured in an average season.

Many of the grasses were in bloom by the first of July. Most of them reached full maturity during August, and remained in a dried up condition through September. The radical leafy growth of the two fescues, of *Agropyron occidentale, A. dasystachyum subvillosum* and *Bromus pumpellianus,* however, remained green during that month. In October unusually fine weather prevailed, and, as there was considerable moisture in the soil from the rains of September, all the grasses made a little growth.

Bromus pumpellianus, or Western brome-grass, appears to be particularly valuable. In thriftiness and amount of leafy growth it surpasses both *Bromus inermis* and *B. marginatus.*

Melilotus officinalis made a dense growth, eight inches high, completely covering the ground. It was entirely killed by a freeze on September 11.

Poterium sanguisorba grew quite thriftily this season. It attained a height of from 13 to 20 inches, blossomed freely and matured seed. It was unaffected by the freeze of September 11, and remained green until late in the fall.

The following is a tabulated record of this the second year's growth of the grasses:

Record of Second Year's Growth

Explanation—(A). 10—perfect;

Species of grass.	Stand	Amount of early growth (B)	Date heads appear, about—	Blooming Season		Amount of stem leaves (B)	Amount of radical leaves (B)	Height of stems	Character of Stems
				Begins about	Ends about				
Agropyron caninum	8	8	June 15	June 24	July 8	7	8	18	of avg. fineness
" occidentale	7	6	July 1	Aug 4	Aug. 18	6	9	18	" "
" richardsoni	6	8	July 10	Aug. 1	Aug. 10	7	8	15	" "
" dasystachyum subvillosum	7	6	June 5	July 8	July 18	6	9	16	fine
" spicatum	8	7	June 1	July 1	July 8	9	9	20	"
" spicatum inerme	7	7	June 1	July 1	July 8	9	9	15	"
" tenerum	9	8	June 15	June 24	July 8	7	8	18	of avg. fineness
Bouteloua oligostachya	¼	....	....	....	....	....	....	....	....
Bromus inermis	9	7	June 11	July 8	Aug. 4	7	8	15	of avg fineness
" marginatus	9	7	June 15	July 1	July 18	7	6	18	" "
" pumpellianus	5	9	June 5	June 15	July 8	7	10	21	" "
" richardsoni pallidus	1	8	June 24	July 20	Aug. 1	6	8	15	fine
Elymus canadensis	9	6	Aug. 1	Aug. 11	Aug. 18	9	6	36	rather coarse
" glaucus	6	6	June 27	July 18	Aug. 4	9	7	18	of avg. fineness
" virginicus submuticus	9	6	July 18	Aug. 1	Aug. 11	9	6	12	rather coarse
Festuca pratensis	5	7	June 11	June 24	Aug. 4	6	8	20	fine
" rubra	2	7	June 11	June 24	July 8	6	8	20	"
Stipa viridula	5	5	June 24	July 1	July 15	7	7	15	of avg. fineness

PLANTING OF CERTAIN GRASSES AND FORAGE PLANTS.—Owing to the lack of moisture, most of the grasses and other forage plants failed to come up. The spring was cold and backward, and there was scarcely any rain. The precipitation for May was only 0.26 inches and for June 0.6 inches, as compared with 3 inches in May and 1.73 inches in June, 1901, when good stands of many grasses were secured.

Sixteen fortieth-acre plats were seeded to grasses in the spring. None of the grasses came up, and it was not until after the plats had been irrigated that a thin stand of seedlings appeared on a few of the plats. None of these grasses grew much during the summer, and at the close of the season the leaves were not over two inches long. Thirty-one twentieth-acre plats were also planted, but none of the grasses came up.

of the Grasses, and other Notes.
(B), 10—very abundant.

Date mature, about—	Yield of seed (B)	Seed-holding power (A)	Evenness of ripening seed	Habit	Awns
Aug. 4	8	6	very uneven	bunch grass	awned
Sept. 20	4	8	fairly even	forming open sods	awns short or none
Aug. 29	8	6	" "	bunch grass	awned
Aug. 11	4	7	" "	forming open sods	without awns
Aug. 21	9	6	somewhat uneven	bunch grass	with or without awns
Aug. 15	9	6	" "	" "	nearly awnless
Aug. 17	8	6	quite uneven	" "	awnless or awns very short
. . . . .	..	..	. . . .	sod-forming	. . . .
Aug. 20	8	10	quite uneven	. . . .	. . . .
Aug. 12	9	6	very uneven	bunch grass	short-awned
Aug. 7	4	10	quite uneven	habit of Bromus inermis	"
Aug. 20	8	10	fairly even	bunch grass	"
Sept. 8	9	9	even	. . . .	. . . .
Sept. 1	6	8	uneven	. . . .	. . . .
Sept. 8	9	9	even	. . . .	. . . .
Aug. 11	7	..	quite uneven	. . . .	. . . .
Aug. 4	1	..	. . . .	. . . .	. . . .
Aug. 15	7	6	very uneven	bunch grass	long-awned

On acre plat 15 thirty-five pounds of seed of *Agropyron tenerum* were sown with a press drill. A fair stand was secured, and the grass did well, remaining green until late in October.

Various perennial saltbushes were sown on acre plat 11. Only a few seedlings of some of the species sown appeared, and these made a considerable growth during the season, the stems attaining a length of a few to twelve or even eighteen inches. On July 15-16 the plats were irrigated, and as a result a considerable number of seedlings of certain saltbushes appeared. These seedlings made little growth, being less than two inches high at the end of the season.

Half an acre was seeded to annual saltbushes on May 23. Since the spring was very dry, they did not come up until after the rains of July. Several species made fairly good stands dur-

ing the month of August. Since they were so late in coming up, they had not made very large growths by September 11, when they were more or less injured by a severe freeze. The larger plants of *A. argentea* had attained a height of about a foot and were quite broad. *A. philonitra* was 12 to 15 inches high. *A. truncata* put out stems a foot long, and since only slightly injured by the freeze, it produced some seed.

EXPERIMENTS IN RANGE IMPROVEMENT.—Various forage plants were sown in the spring on a four-acre piece of land in the Station pasture. The land was scarified with a harrow of the peg-toothed type, and the seeds, after being broadcasted, were harrowed in. On account of the dryness of the season, nothing came up.

Late in the fall an acre of land in the same pasture was disc-harrowed and laid out into fortieth-acre plats. The seed was broadcasted on October 25 and harrowed in. After a careful examination of the plats on June 17 this spring, it was found that all the plants sown in the fall were up.

RANGE CONDITIONS IN 1902.—Notes were taken during May and June on the growth of the native forage plants in the pasture, but none were taken after that, as there was scarcely any growth on the range during July, August and September. The pasture under observation, as well as the open range on the Laramie plains, showed the effects of the drought. The feed was very poor, or almost nil. The grasses made very little growth, and those which in 1901 grew luxuriantly did not even head out. There was some growth during May, but in June it was exceedingly dry, so the pasturage did not improve and the grasses did not appear to grow much until in October.

ESTABLISHMENT OF A PERMANENT MEADOW.—Plans were made for the establishment of a permanent meadow, using a part of the unbroken land in the southern part of the farm. An acre and a half was disced, some grass seed sown and har-

rowed in. Since we were unable to irrigate the land, the experiment was not carried out.

Experiments in Methods of Seeding Saltbushes.—Under the climatic conditions existing in the region, it has been found difficult to secure a stand of most saltbushes. It has, therefore, seemed well to try different methods of seeding these forage plants. The experiments instituted were designed to determine (1) the relative value of late fall and spring seeding, (2) the optimum depth of covering the seed, and (3) whether better results may be secured when the seeds are covered than when left on surface of the ground.

The first planting was in the fall of 1901, *Atriplex argentea, A. Nuttallii* and *A. truncata* being the species used. The best stands were on the plats where the seeds had been planted one-half inch deep. The plat on which the seed had been planted an inch deep did not give as good a stand, and where the seeds were left on the surface of the ground only a few plants appeared.

The spring planting was done on May 10, 1902. Nothing came up on these plats. Since the spring was unusually dry, this planting cannot be considered a fair test.

The experiments were again carried out in the fall of 1902 and spring of 1903. In these two plantings only one species, *Atriplex Nuttallii,* was used. These plats were examined on June 24, but as seedlings were very small at that time, very accurate notes as to relative number of seedlings on the different plats could not be taken. The examination made, however, evidenced results agreeing very closely with those obtained from the fall planting of 1901. The plats planted in the spring were giving results as good and about the same as the plats planted in the fall.

The practical value of subjecting saltbush seed to the action of moisture for a length of time before planting has been tested. Lots of seed of *Atriplex argentea, A. Nuttallii* and *A.*

truncata were stratified in moist sand and kept in a cool cellar for sixty days before they were planted. Dry seeds of the same species were planted at the same time for a check. From the stratified seeds of *A. argentea* and *A. truncata* a few plants appeared, but none of the seeds planted dry came up.

Germination Tests.—Germination tests were made of the seed on hand for planting in the spring of 1902. The seed tested was of native species and had been gathered from plants growing wild on the Laramie Plains. The results of the tests were as follows:

Atriplex aptera, 2 per cent.
Atriplex argentea, 0 per cent.
Atriplex canescens, 0 per cent.
Atriplex nuttallii, 3 per cent. (average of 3 tests).
Atriplex pabularis, 2 per cent.
Atriplex philonitra, 27 per cent.
Atriplex truncata, 39 per cent.

In those species of which none or very few seeds germinated, the bracts enclosing the seeds are very thick and hardened, while in the two annual species, which have the larger percentages of germination, the bracts are not so much thickened and indurated, and this fact no doubt accounts for the much larger percentages of germination which they gave.

Husked Seeds.—To ascertain whether the seeds were not really viable, 25 seeds of a representative species, *A. Nuttallii,* were with some difficulty removed from the husks and placed in a pocket of the germinating pan. Twenty-four of these seeds germinated. From this experiment it would seem that the tough, indurated bracts are a decided hindrance to the germination of the seeds, and it is evident that they germinate readily when removed from this hard covering. A higher percentage of germination may, therefore, be expected if by any treatment the husks can be softened or partly or entirely removed from the seeds. It was found that by running seeds

(properly fruits) through a hand grinding mill a goodly number of seeds could be removed uninjured. Seeds of five species were accordingly subjected to this treatment and planted under the same condition, and in the same manner as were the untreated seeds. Four of these species furnished no data bearing on the problem to be solved, since they made very poor stands. Of *Atriplex argentea,* however, an equally good stand was secured from both lots of seed, but the plants from the treated seeds appeared much earlier and were considerably the larger at the end of the season.

WORK DURING THE SPRING OF 1903.—The spring of 1903 in this section has been marked by abundant showers, but rather low temperatures. The range has been in excellent condition, and the grass on the plains was more abundant early in June than at any time during 1902. The liberal supply of moisture has made the spring unusually favorable for our work, and nearly all grasses and other forage plants sown have come up.

The grasses on the permanent plats have made large growths this spring and present a fine appearance. These plats are being observed and the notes taken recorded on the blanks furnished by the Agrostologist of the U. S. Department of Agriculture.

Fourteen of the vacant fortieth-acre plats on acre plat 21 were seeded to grasses May 14. The plats were disced and harrowed smooth and the seed sown broadcast and harrowed in. All of the grasses sown, with one or two exceptions, are now up, and some of them have made very good stands. Seeds of awnless forms of *Agropyron tenerum* and *A. occidentale* collected last season were sown in rows by hand on one of the vacant plats. These have also come up.

Through the good will of Mr. Otto Gramm, the Experiment Station has been given the use of a piece of land on the Grace Creek ranch, located on the Laramie river, for an experiment in the making of a permanent meadow on a scale large

enough for practical results. The land used is a three and a half-acre field, under ditch and gently sloping toward the river, in a valley half a mile wide. It was cleared of a dense growth of sagebrush the past season and broken this spring and a seed-bed prepared. On May 25-27 it was seeded to a mixture of grasses and other forage plants, broadcasted at the rate of about 25 pounds to the acre and harrowed in. The composition of the mixture was as follows:

Bromus inermis, 2 parts.
Bromus marginatus, 1 part.
Agropyron tenerum, 2 parts.
Vicia villosa, 2 parts.
Onobrychis sativa, 2 parts.

Some of this same mixture was sown on one-third of an acre on the Experiment Farm.

The seed of various species of *Atriplex* on hand for planting was put in on acre plat 23. This land had been plowed and harrowed in the fall. The seed was, therefore, broadcasted on May 15 without any cultural treatment of the soil immediately previous to the planting and harrowing in.

ELIAS NELSON,
Assistant in Horticulture and Agronomy.

Publications Coming to the Station.

American Agriculturist,
American Cultivator,
American Fertilizer,
American Gardening,
American Grange Bulletin and Scientific Farmer,
American Hay, Flour and Feed Journal,
American Sheep Breeder and Wool Grower,
Agricultural Experiments,
Agricultural Journal and Mining Record (Maritzburg, Natal),
Baltimore Weekly Sun,
Beet Sugar Gazette,
Boletin da Agricultura (Sao Paulo, Brazil),
Boletin de la Comision de Parasitologia Agricola (Mexico),
Breeders' Gazette,
Chicago Daily Drover's Journal,
Chicago Live Stock World,
Country Life,
Denver Record Stockman,
Elgin Dairy Report,
Engineering News,
Farmer's Advocate,
Farmer's Guide,
Farmer's Review,
Farmer's Tribune,
Farm Fireside,
Feather,
Field and Farm,
Floral Life,
Florists' Exchange,
Flour and Feed,
Hoard's Dairyman,
Homestead,
Indiana Farmer,
Inter-Mountain Farmer,
Irrigation Age,
Journal of the Royal Horticultural Society (London),
Kansas Farmer,
Les Plagas de la Agricultura (Mexico),
Louisiana Planter,
Massachusetts Plowman,
Mirror and Farmer,
Modern Farmer,
Montana Stockman and Farmer,
National Farmer and Stock Grower,
Nebraska Farmer,
New England Farmer,
Ohio Farmer,

Orange Judd Farmer,
Our Grange Homes,
Pacific Homestead,
Pacific Rural Press,
Press and Horticulturist,
Ranch News,
Reliable Poultry Journal,
Republic,
Rocky Mountain Husbandman,
Southern Farm Magazine,
Successful Farming,
Sugar Beet,
Texas Farmer,
Trade,
Up to Date,
Wallace's Farmer,
Weekly Statistical Sugar Trade Journal,
Weekly Live Stock Report,
Western Fruit Grower,
West Virgina Farm Reviews,
Wyoming Industrial Journal.


Old Penitentiary Buildings at Laramie.

The University of Wyoming

Agricultural College Department

FOURTEENTH ANNUAL REPORT

. . . OF THE . . .

U. S. Agricultural Experiment Station

. . . OF . . .

WYOMING

1903-1904

PUBLISHED DECEMBER, 1904

LARAMIE, WYOMING,
U. S. A.

Letter of Transmittal.

U. S. AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF WYOMING.

To His Excellency, Fenimore Chatterton, Governor of Wyoming.

SIR:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating Agricultural Experiment Stations, I have the honor herewith to submit the Fourteenth Annual Report of the U. S. Agricultural Experiment Station of Wyoming, for the fiscal year ending June 30, 1904.

B. C. Buffum
Director.

UNIVERSITY OF WYOMING, June 30, 1904.

WYOMING

Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

*Died June 19, 1904.

Table of Contents.

Report of Station Staff.

Report of the Director.

Origin and Purpose of the Station.—The thirteen annual reports preceding the present one give a history of the Station work up to the beginning of the last fiscal year. The year 1903-4 has marked an important change in the general reorganization of the Station work and the beginning of important investigations in animal industry. The following condensed statement of the purposes and history of the Station was given in my report last year:

Briefly, the purpose of the Station is *research* in agriculture, and the publishing of such bulletins and reports as will enable our people to put to practical use the results of this research. The fact that this expenditure and work is primarily for the benefit of the people of Wyoming does not seem to be so generally understood as it should be. Many do not realize the purport of the fact that the most progressive nations are generously fostering both the theoretical and practical education of those engaged in every agricultural industry. In our own country the two Morrill acts establishing and supporting our Agricultural and Mechanical Colleges provide for the foundation education of our youth, and the Hatch act of 1887 makes an appropriation by Congress of $15,000 annually to each State and Territory for scientific research in agriculture and the dissemination of the results of such investigations to the people through agricultural bulletins, which are sent free upon request for them. Some experimental work was done in Wyoming as early as 1890, and on January 10, 1891, the Legislature author-

ized the University of Wyoming to receive the appropriation by Congress for the establishment of an Experiment Station. The work of the Station was organized and a Station Staff elected in March and April of 1891. The results of the Station work and executive details up to the beginning of the last fiscal year are published in the thirteen annual reports, the sixty-two regular bulletins, and the various press bulletins which have been issued.

THE STATION COUNCIL.—The Experiment Station Council is the executive body which passes on all matters pertaining to the Station policy, work and publications. It is composed of the President of the University, as Chairman; the Secretary of the Board, who is Secretary of the Council; the Director of the Experiment Station, as its executive head; and those professors and assistants in the University and Agricultural College who do research work. The Station Council meets regularly on the second Thursday of each month, and additional meetings are called whenever occasion demands.

The Council recommends plans for work in the several departments of the Station and all bulletin material for publication, to the Agricultural Executive Committee of the University Board of Trustees for their adoption. The bulletins as prepared are read and discussed in open council meetings. This plan of passing on the bulletins has given much satisfaction. It prevents extravagant statements and insures a more complete discussion of the results of an investigation than might be made by the writer alone. The subject matter and composition are freely criticised, and the material prepared may be accepted for publication, or referred back to the writer for revision, postponed or entirely thrown out. This arrangement brings the Station workers very closely together, and provides for co-operation along any line of work in which two or more departments may be able to take part. The writer of a bulletin may select two other members of the Station Staff to aid him in reading proof.

CHANGES IN STATION STAFF.—Elmer E. Smiley, A. M., D. D., resigned his position as President of the University and Dr. Charles Willard Lewis, Sc. M., D. D., was elected to fill the vacancy, and began his duties September 1st. It is with the deepest regret that I must here chronicle the death of President Lewis, which occurred on June 19th, 1904. Never has any man during the first year of his connection with our institution done harder or more effective work in its interests. President Lewis was a great stimulus to the members of his Faculty, and entered into the reorganization and building up of the Agricultural College and Experiment Station work with energy and enthusiasm. He gave your Director much encouragement and unselfish support for the broadening and carrying forward of every plan which would increase the efficiency of our agricultural work.

Professor E. E. Slosson, M. S., Ph. D., who was Chemist of the Experiment Station since July, 1891, was given a leave of absence at the beginning of the school year, and in the following April he tendered his resignation to become the Literary Editor of the *New York Independent*. Professor H. G. Knight, A. M., was made Acting Chemist in the University and Experiment Station, and State Chemist during Professor Slosson's leave of absence, and when the latter resigned he was made Professor of Chemistry in the University and Chemist of the Experiment Station.

It is also with the deepest regret that we announce the death on July 28, 1903, of Professor Wilbur C. Knight, who has been Geologist of the Experiment Station and a valued member of our Station Council since 1893. Professor Knight was an indefatigable worker, and among the publications of our Station will be found several bulletins written by him. He took no small part in making the early history of our Station, and his loss to the institution and to the state is irreparable. In reorganizing we have thought it wise to put more

stress on purely agricultural research, and on that account the chair of Geology is dropped from our Station Staff.

Mr. Elmer E. Sigman, who has been foreman of the Experiment Station Farm for six years, resigned on March 1, 1904, and Mr. W. E. Field was appointed head farmer to take his place.

Mr. Henry C. McLallen, M. S. A., was appointed Assistant Agriculturist, and began work in April, 1904, taking up his residence in the house at the new penitentiary farm.

The many changes here noted have had a marked effect on the Experiment Station work, and account for the comparatively small amount of bulletin material published during the year. At the same time, much was done in reorganizing the Experiment Station work and the beginning of investigations with animals which will mean much to the live stock interests of the state.

CO-OPERATION.—But little work was done in the past year in co-operation, but enough so this report would not be complete without a record of it. The principal co-operative work during the year with the Department of Agriculture was that undertaken in association with the Chief of Irrigation Investigations of the Office of Experiment Stations. This work was in charge of our Irrigation Engineer, and Mr. Fleming spent the larger part of the summer season in the field making measurements to determine the losses and gains by seepage to canals and streams of the Laramie Plains and in the Wheatland district. The results of this work are published in Bulletin No. 61. In the season of 1903 one-half acre of sugar beets was raised by the Experiment Station in cooperation with the Division of Chemistry of the United States Department of Agriculture, and the present season we have grown some plats of flax from seed obtained in Russia by Professor Bolley for the Division of Plant Industry of the United States Department.

We have co-operated in a small way with a few ranchmen. The principal work of this kind has been done in connection with the Grace Creek Ranch, where about eleven acres of alfalfa and three acres of mixed grasses were planted, at an altitude of over 8,000 feet, on the Big Laramie River. The expenses for seed and work were paid by the Grace Creek Company, and the planting was overseen by our Station men. Excellent stands were secured of both the alfalfa and the mixed grasses, but the alfalfa has made comparatively small growth. An examination the present season would indicate that the small amount of growth the second year from seed is probably due to a combination of three things. First, the season has been a very cold one and many night frosts at high altitudes have greatly retarded growth. Second, the indications are that the soil upon which the alfalfa was planted is poor in plant food. It is undoubtedly especially poor in nitrogen. And, third, our examination failed to discover nodules on the roots of the plants. An attempt will be made to inoculate the soil with the proper bacteria on a part of the plat to determine whether or not such inoculation will improve the growth.

Grass seeds were furnished to a few ranchmen in other parts of the state, but no reports have been received from them. Other co-operation has been made only in a small way, as heretofore, by loaning implements from the Experiment Farm to ranchmen who were attempting, for the first time, to grow alfalfa or other seeds which require the use of a press drill to insure success. However, it is probable that such loaning of Experiment Station implements will not be continued in the future.

One of the most important lines of co-operation which we will take up the coming year is that in sheep breeding with the F. S. King Brothers' Company of Laramie, and it is likely some other co-operative live stock experiments may be inaugurated. We are hoping to continue co-operation with the

Office of Experiment Stations, and we have encouragement that such will probably be done. The present season Mr. Fleming spent some time working for the Office of Irrigation Investigations in Cheyenne assisting in establishing a meter rating station, and it is expected, also, that he will furnish data on the duty of water as obtained by the Station in return for favors from that office. Mr. Fleming spent a part of the present season assisting Mr. John E. Fields in obtaining irrigation information along the North Platte River, under the Pathfinder project.

MIXING WITH THE STATE'S AGRICULTURAL ACTIVITIES.—We have attempted to keep in touch with agricultural and stockmen's meetings in the state. In addition to the regular Station duties of the Director, mixing somewhat with the general agricultural activities in the state has seemed desirable to our Board and has been more or less unavoidable. In July I attended a meeting of the northern stockmen, held at Meeteetse, Big Horn County, to discuss the forest reserve problems of that section of the state. At the same time some studies were made of the agriculture and live stock industries of the Big Horn Basin, and some photographs were secured of ranches and stock around Meeteetse and Cody. Studies were made of the ranch management on the stock farm of Mr. Otto Franc, one of the largest growers of alfalfa in Northern Wyoming. Mr. Franc has probably done more in reclaiming alkali and seepage land than any other man in the state. The results he obtained are of great importance, and we were given every opportunity to study these results. Mr. Franc became much interested in our Experiment Station work. The farm of the Experiment Station at Laramie and that of Mr. Franc, on the Grey Bull River, present conditions very much alike in soil, climate, season, and native vegetation. He was a man with keen interest in scientific work, and his death later in the year was a personal loss to myself, and a loss to the Station as well. I also visited the ranch of Mr. O. B. Mann, at

Meeteetse. Mr. Mann is the only breeder of registered Shorthorns in that section of the state, and has a herd of which he is justly proud. He also became interested in the Station work with stock, and in a generous public spirit he has offered to present the Station with a fine bull of his own raising when we are ready for him. There was a large meeting of stockmen at Meeteetse on July 15th. While there was much difference of opinion expressed, there seemed to be a general agreement that too much land not bearing forest was set aside in the Yellowstone and Big Horn forest reserves, and that the contraction of the ranges had seriously affected the range business, especially the ranging of sheep.

The middle of September I attended the Irrigation Congress at Ogden, Utah, and made an exhibit there of forty-four varieties of brewing and hulless barleys in grain and straw, which had been grown by the Station at Laramie. On September 22, 23 and 24 the Station and College made quite an extensive exhibit of high-altitude products and stock at the First Albany County Fair, and the same exhibits were taken to Sheridan, where they were shown in connection with the State Industrial Convention and State Fair, October 6, 7 and 8.

The agricultural exhibits brought together at Sheridan were shipped to Laramie, where they were stored and prepared under my supervision for the State exhibit at the Louisiana Purchase Exposition, in April. I went to St. Louis and assisted in installing the exhibit. A part of the time of Mr. E. Nelson, Assistant in Horticulture and Agrostology, was given to the storing, preparing and installing of the agricultural exhibits, the State World's Fair Commission paying his expenses and reimbursing the Station for his salary during the time occupied with this work. During the year several ranches in the state were visited and the methods of stock management studied. It may be said that the year has marked a much better feeling toward the Station on the part of our ranchmen. The results of the Station investigations are being more gen-

erally used by our people than ever before, and our supply of several important bulletins has been exhausted. I also visited the International Live Stock Exhibition at Chicago in December and the Short Course in Stock Judging at Ames, Iowa, in January.

ASSOCIATION MEETINGS.—President C. W. Lewis represented the Agricultural College and the Director represented the Experiment Station as delegates to the meeting of Agricultural Colleges and Experiment Stations held in Washington, D. C., November 17, 18 and 19, 1903. I reached Washington early and attended a conference meeting on co-operation between the Department and the Stations in Irrigation on November 16, which was called by Professor Elwood Mead, Chief of the Irrigation Investigations.

The matters of especial importance to the College and Station which occupied our attention at the time of the association meeting were the selection of a Chemist to take up the work which had been carried on by Professor Slosson, the gathering of information which would aid us in establishing a course in Irrigation Engineering in the University, the offering of a winter short course to ranchmen, and the establishment, if possible, of a regular Weather Bureau Station at the University.

THE WINTER SHORT COURSE.—The Short Course is an Agricultural College matter, and is not properly a part of the work of the Experiment Station, but it is here mentioned because it has an important bearing on the Station. The equipment for investigations in irrigation and live stock was used. The first Short Course offered at the University was held from March 1 to March 12, 1904. The first week was given over to irrigation studies, and the second week to live stock judging and management. The course was attended by 130 persons, seventy-three of whom were ranchmen, representing many parts of the state. New interest was awakened in the Experiment Sta-

tion investigations, more especially, perhaps, in the new work being taken up with live stock. We believe the Short Course did more than anything else which has happened to create an interest in and a sympathy with our investigations. It has brought us into touch with our people in a way which should secure support that will materially aid the work. Our stockmen are coming to appreciate the work being done and our needs for better facilities. Some invaluable co-operation was promised by ranchmen. During the year the Station has become a living reality among our people, and is meeting with an appreciation which augurs well for the future.

NEW STOCK EQUIPMENT.—In the last annual report a general statement was made in regard to the live stock work which, in our judgment, should be taken up by the Station. Every possible support was given to the furtherance of the plan by the Board of Trustees, and every dollar which could be used to help the Station get started in the stock work was appropriated for the purpose. Fourteen hundred dollars of the state fund was used for the purchase of buildings from the Broom Company, which had operated in connection with the state penitentiary before that institution was removed from Laramie. These buildings, along with the penitentiary building proper, and 320 acres of land which belongs to the state, gave a place for live stock work, and some stock equipment was secured during the year, but the limited funds only enabled us to begin in a small way. For breeding purposes we can only use blooded strains, and such stock is expensive.

HORSES.—In August we purchased two Oldenburgh Coach stallions and four grade mares in Omaha. The stallions had been imported by Crouch & Son for John W. Springer and used on his Dakota Hash Knife Ranch. The mares were three-quarter Coach and one-quarter mixed Hambletonian and native blood. Unfortunately, glanders broke out in these mares in March and three of them were destroyed in July by the State

Veterinarian. This is a serious handicap in our horse breeding work, and we hope the Legislature will enable us to replace the loss, as we can do nothing in horse breeding without a harem of mares for the purpose. These horses were purchased from state fund and the stallions were used for outside service the present season. Only two mares now belong to the Station which we can use in the breeding experiments. This year, however, nine or ten outside mares, belonging to ranchmen in and around Laramie, are with foal from our Coach stallions. These colts we expect to keep under observation as far as possible, and they should give us some idea of what the German Coach horse will do when bred to the native mares of this region.

These stallions had been run on the open range for three or more years and we bought them at a closing out sale, at a price which enabled us to make a beginning in horse breeding with our limited funds. It has been thought that the Oldenburgh Coach stallion will be an excellent horse with which to add weight to the native range stock, at the same time giving style and conformation which will improve our western horses for general purpose and cavalry animals. We would obtain sound feet in such breeding, and the Coach horse seems one of the best to secure improvement in the docility and tractability of the range type. After obtaining such improvements and the elimination of so much of the native blood as is thought desirable, it may be well to use some warmer blood, as Thoroughbred, Hambletonian or Morgan sires to increase stamina, speed and staying qualities. It would seem, however, that without some material support the work cannot be carried out.

CATTLE.—As stated last year, we had on hand two Hereford cows and one Shorthorn cow, with two calves of her get. As an interesting and valuable line of work in cattle breeding, we have added by purchase two animals of the Double Standard Polled Herefords, a bull and heifer, both out of the orig-

inal Polled Sport Giant, owned by Warren Gammon of Des Moines, Iowa. As our bull was purchased before he was weaned, a common nurse cow was purchased. The animals obtained were too young to breed, but they are high priced and high quality individuals, which have attracted much attention in the state, and which will be heard from in the future, if nothing happens to them. In order to help establish the new breed of Registered Polled Herefords, it will be necessary to obtain additional heifers, and some provision should be made for funds for this purpose.

SWINE.—Work was begun with the bacon type of swine, and three good registered Tamworth sows were purchased from the Colorado Station, and a boar from the Iowa Station at Ames. These animals and their progeny will be used to determine the cost of production of pork at our high altitudes. We hope to add another type of swine for crossing and comparison.

SHEEP.—The sheep on hand were a few California Rambouillets, which were of unknown breeding and not registered. On this account they were sold during the year. Arrangements have been made for some experiments the coming year with pure bred, fine wooled sheep in co-operation with the F. S. King Brothers of Laramie, and it is expected a small amount of money will be used for the purchase of registered breeding stock.

POULTRY.—There is a small flock of turkeys on the Station farm, and we purchased seven dozen chickens which were in the yards when we secured the buildings belonging to the Broom Company at the old penitentiary. Some chicks were raised by incubator and the old stock sold. We need new stock of full blooded fowls, in order to continue the work.

NEEDS.—Live stock is the principal industry of the state, and our stockmen should come to the support of the stock in-

vestigations by the Experiment Station. The U. S. Hatch fund is not sufficient to provide stock in kinds and amounts which will make the work effective. The first cost of obtaining blooded stock suitable for breeding experiments and of equipping a station for caring for such stock is necessarily large, but after the equipment is obtained this work can be made practically self-supporting and at the same time be of great value to the stockmen of the state. The coming Legislature this winter should permanently give the old penitentiary property at Laramie to the University for Experiment Station purposes. Along with this transfer, they should provide an appropriation of not less than $5,000 to be used in remodeling the buildings and yards, and the construction of suitable fences and drains to put the place in shape for effectively caring for live stock, and another $5,000 with which to purchase suitable animals to stock the farm. With such appropriation of $10,000 the live stock work could be put on a fine and permanent self-supporting foundation, which will bring more lasting benefit to the state than any other legislation which could be enacted at this time. We urge our stockmen to show their interest in this matter in such a way that the coming Legislature will provide the necessary place and funds to inaugurate this work which means so much for the future development of the state.

RESEARCH WORK.—It is the opinion of the Director that more pure research work should be done in the Station. Under the law, the Experiment Station has but one object. It is established and supported for research in agriculture. The only extension or industrial work contemplated by the organic law under which our Stations operate is the publication of bulletins reporting the results of this research, and these bulletins are mailed free to our farmers, in order that they may make use of the results obtained. Experimental research is necessarily expensive. There is no immediate profit in research to the one carrying it out, and our farmers cannot afford to experiment

so long as they have a Station in their midst which is established for that purpose. On account of our Station workers being also teachers in the University and Agricultural College, they are unable to devote as much time to the Station research as will enable them to get a large amount of work done. This fact is recognized by the Board of Trustees and, with the exception of the Director, who is also Agriculturist, and the Secretary, none of the heads of departments represented in the Station Staff receive any part of their salary from the Hatch fund. There are assistants, however, who are paid from this fund, and whose time is given more directly to the Station work. Some of these are student assistants, who give a part of their time to clerical work, and others are regular assistants, who carry out plans of experimentation. I feel that more research should be going on in the several departments which make up the Station Staff, and the coming year we plan to add a Research Chemist, who will take up work with our forage plants and stock foods. A large part of the farm land has been seeded to alfalfa, in order to cut down the amount of money required to conduct the general farm operations, and more of the funds will be used for experimentation. In the past good work has been done in research by the heads of the several departments, but the men are burdened with teaching, and if they would continue consecutive experimentation they must depend largely on the assistants to carry out the details of the work under their instructions.

There have been and there still are too many departments combined into one. The future will undoubtedly be marked by separation of departments, allowing the assistants to become professors in charge of their special lines of work. Of necessity we must soon have a Professor of Irrigation or of Farm Engineering. The growth of the irrigation work in the Station and the establishment of an Irrigation Engineering course in the University makes the work too great to be retained as a part of the Department of Agriculture much longer.

Another division which must of necessity soon be made is to give the work in Animal Industry the dignity of a department with its professor in charge. I would favor such arrangement as that prevailing at the Iowa Station, in which the work in agriculture is controlled by the Director and Dean, but each division of the work is under its head professor and corps of assistants in charge of all details of the work.

PUBLICATIONS.

The publications during the year include the Thirteenth Annual Report for the fiscal year ending June 30, 1903, which was published in July. This report outlines the work as organized under the new regime of a Director, as official head of the Station, separate from the Presidency of the University, and makes detailed statements of the plans for experimental work with live stock and the use to be made of the old state penitentiary property as a new part of the Experiment Station equipment. This report also contains plans of Station work by each member of the Staff and statement of the investigations carried on in the several departments during the year. There is also a brief technical report of the results obtained in the work with grasses and forage plants. The bulletins published during the year were four in number, as follows:

Bulletin No. 59, November, 1903. The Wheat-Grasses of Wyoming, contains 34 pages, 5 plates, and 6 figures with the text. This bulletin was written by the Botanist, Professor Aven Nelson, and the Assistant Agrostologist, Mr. E. E. Nelson. It is the second bulletin in the series treating of Wyoming grasses, the first being No. 46, on the Brome-Grasses of Wyoming. It gives a general statement of the occurrence and importance of the species of *Agropyron* found in the state, the ecology of the native forms and their management in irrigated meadows. There is also detailed account of plat experiments with nine species of Wheat-Grasses at the Wyoming Station.

Bulletin No. 60, December, 1903, Wheat Growing on the Laramie Plains.—This bulletin contains 40 pages of text and 8 plates illustrating the different types of wheat which have succeeded at Laramie. It is written by B. C. Buffum, the Agriculturist of the Station, and gives a general account of the conditions which favor wheat growing at high altitudes in Wyoming, a resume of the experiments with wheat and the publications on the subject since the Experiment Station was established, a general account of the kinds and usefulness of the different kinds of wheat which have been grown, a general statement of the varieties which have succeeded best during several years in which they were cultivated, and an outline of wheat culture for Wyoming conditions.

Bulletin No. 61, March, 1904, Seepage Investigations, a 32-page bulletin written by the Irrigation Engineer, Mr. B. P. Fleming. It is illustrated with one plate and two charts. This bulletin reports the results of seepage measurements made during the season of 1903 along the Laramie River from Wood's Landing, near where it enters the state, to its mouth at Fort Laramie, along the Pioneer Ditch, Sand Creek, the Divide Ditch, the Highline Canal and the canals supplying the Wheatland colony. It shows the amount of losses and gains in the streams and ditches studied in different parts of their courses, and contains much valuable information about that part of the water supply which heretofore has been given little attention in this state.

Bulletin No. 62, May, 1904, Some Food Products and Their Adulteration, written by Professor Henry G. Knight, Chemist of the Station, and State Chemist, and Mr. Ross B. Moudy, Assistant State Chemist. This bulletin of 56 pages is the second bulletin on pure foods published by the Station. It reports a total of 425 analyses made of food products as sold in Wyoming. Of this number, 268 were found to be adulterated and 157 that are pure. Statements are made of

the adulterants used and of their supposed effect on the health of those who habitually use foods containing them.

THE RANCHMAN'S REMINDER.

The Ranchman's Reminder is a monthly paper published by the University. While it is not a Station publication, it is closely related to the Station and its work, keeping the farmers informed about the investigations being conducted, the plans of work for the future and small items in the nature of results of investigation or knowledge being capable of being applied on the farm, which have heretofore been published in the form of press bulletins. From January 1st until the end of the fiscal year one number was published each month, there being a total of 80 pages in the six numbers. The articles contained, which would otherwise have been published in press bulletin form, were one on "Alfalfa for Horses" in the January number, one on "Berseem" in the February number, one on "Six Salable but Unsuitable Seeds," another on "A Double Entry System of Live Stock Accounts," and a third on "Tree Planting Time," in the March number, and such articles in the April number were "Grass Gossip," "The Polled Herefords," "Importance of Stock Feeding Investigations at High Altitudes," and "Lawns." In May there were two such articles, one on "The Flower Garden," and one on "Dwarf Rape," and in June there was an article on "Wyoming Ground Squirrels." On account of having published these articles, no press bulletins, so-called, were sent out by the Station during the year. The Ranchman's Reminder is an attempt to extend our College and Station work to ranchmen for their immediate and timely use. It is one of the helps which has come to the Station in addition to the use of its own funds.

Financial Statement of the Treasurer.

UNIVERSITY OF WYOMING,

AGRICULTURAL EXPERIMENT STATION,

. . . In Account With . . .

THE UNITED STATES APPROPRIATION, 1903-1904.

DR.		
To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1904, as per act of Congress approved March 2, 1887		$15,000.00
CR.		
By Salaries	$ 4,761.65	
Labor	2,981.27	
Publications	973.91	
Postage and stationery....................	396.88	
Freight and express.......................	386.33	
Heat, light and water.........................	1,069.89	
Chemical supplies	345.45	
Seeds, plants and sundry supplies..........	312.25	
Feeding stuffs	842.09	
Library	285.08	
Tools, machinery and implements..........	124.75	
Furniture and fixtures.....................	269.63	
Scientific apparatus	205.80	
Live stock	1,046.80	
Traveling expenses	661.52	
Contingent expenses	27.00	
Building and repairs......................	309.70	
Totals	$15,000.00	$15,000.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Ex-

periment Station for the fiscal year ending June 30, 1904; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000 and the corresponding disbursements $15,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

(Signed) HARRIET KNIGHT,
[SEAL] H. L. STEVENS,
Auditors.

Attest:
GRACE RAYMOND HEBARD,
Custodian.

SUPPLMENTARY STATEMENT.

	Farm Products.	Total.
DR.		
To receipts from other sources than the United States for the year ending June 30, 1904	$2,168.57	$2,168.57
CR.		
Traveling expenses	$ 154.97	
Buildings and repairs	810.07	
Labor	935.28	
Postage	200.00	
Seeds	68.25—	2,168.57

Report of the Agriculturist and Horticulturist.

The outline of Station activities given in the Director's report indicates the general lines of work given prominence in the Agricultural Department. The reports of the assistants to the Agriculturist and Horticulturist published herewith cover a part of the technical and general work which has been carried out. These assistants are, first, the Irrigation Engineer, whose report shows the progress of the investigations with duty of water and the amount of water necessary to produce maximum crops, as well as the co-operative work with seepage and water measurements; second, the Assistant in Agrostology and Horticulture, whose report gives a detailed account of the plat work with grasses and forage plants, including the salt sages, and other work which he had in charge; third, the report of the Assistant Agriculturist, which is a brief statement of the work begun the present season since he took charge.

The plans of work for the year, as outlined in the last annual report, have been quite generally carried out. The live stock equipment has been quite materially increased by the purchase of new stock, as stated before, and also by the repairs to buildings and the purchase of supplies. Two United States separators were purchased, but it was found that we could not start our home dairy work with the funds available this year. The co-operative work with one of these separators on the Grace Creek Ranch was begun, but we could not begin a like kind of investigation at the Station, so the extra separator has been paid for and become the property of the ranch. The coming year we hope to obtain cows and other equipment necessary and put our separator into use, when we will make new

arrangements for co-operation. The dairy industry in Wyoming is becoming more important, and there seems no good reason for shipping in any class of dairy products, other than the fact that our people are not themselves yet prepared to supply the demand.

We also purchased a new root cutter for slicing the turnips used in our lamb feeding experiments.

The office of the Director and Professor of Agriculture has been made more comfortable and convenient by building a partition which separates one end of the room into an inner office. The inner office has been carpeted and supplied with a new file case for the Station photographs, which are a part of our records. Mr. John Ernest, one of the large ranchmen on the Laramie Plains, at the time of the Short Course presented the office with a mounted head of a typical Texas steer. This steer was raised by Governor Tarassas of Chihuahua, Mexico, and represents a class of cattle once very numerous in Wyoming, but which have now given place to better breeds.

A new harness and new plow were purchased for the farm. We find the farm implements are badly worn from long use and some new ones will be needed another year. We are especially in need of new wagons, a new harvesting machine, manure spreader, disk harrow, etc.

The records of the Department for the past two or three years have been somewhat broken up by the changes in its head and by the destruction of crops two seasons by hail storms. There is much work ahead of us in bringing the notes together and transferring them to permanent and available form. During the year we have extended record making somewhat, and are now keeping as close track as is practicable of the foods given to each animal and the results of the feeding. It has been necessary to use more money for the farm operations than heretofore, because we have attempted to bring every acre under cultivation, and make the land supply our stock food as far as possible. However, we have been reduc-

ing the amount of land to be plowed and put in general crops each year by seeding it down to alfalfa, which will increase our hay supply. It is impracticable to carry on experimental work with live stock any place without the purchase of some supplies of food from outside, but it is our plan to make our stock self-supporting as far as possible and to make the land which we farm furnish this support. The present season all the larger fields on the upper or old Experiment Farm are seeded to alfalfa, except one field of thirteen acres, which is planted to oats and used for special irrigation investigations. A few of the acre plats on the old farm we hope to keep in the plat work. One of these, A. Plat 8, is used to show the comparative effects of rotation of crops without alfalfa, compared with a rotation with alfalfa. On A. Plat 19 a three-year rotation is practiced with grain, root crop and annual legumes, and on A. Plat 20 small grain is being grown continuously year after year. Acre Plat 19 produced a good crop of oats last year and this year is planted to turnips. Acre Plat 20, on the other hand, has so deteriorated in producing power that the oats and wheat raised on it for several seasons have not been worth harvesting. These experiments furnish object lessons of much importance to our ranchmen, who have not yet learned the necessity of rotation, and who are prone to lay their poor crops to poor soil rather than to their own poor methods of farming.

The present season we have begun some investigation of the White Sweet or Bokhara Clover. Four acres of the poorer alkali soil of the farm have been seeded, and we hope to determine a place of value on our high altitude ranches for this heretofore despised weed. That it has a marked ability to improve poor soils, there is little doubt, and that it has some value as a stock food, we believe, though it will undoubtedly require much experimental work to show just how and where it may be most profitably used. On the penitentiary farm we have sown some pease and a field of rape for pasture this fall and winter.

The principal feeding experiment during the year was carried out with lambs, a brief report of which accompanies this report. Our work with feeding lambs on field pease has resulted in our ranchmen taking the matter up, and Mr. E. J. Bell of the Millbrook Ranch is growing pease the present season for this purpose. The growing of field pease and the feeding of lambs on them promises to develop into a very important industry on the Laramie Plains and on irrigated lands at high altitudes in other sections of the state.

LAMB FEEDING EXPERIMENTS OF 1903-4.

The main object of the lamb feeding experiment this year was to show the value of field pease for fattening lambs at our high altitudes. The experiments planned were sufficiently broad to cover several other feeds and make possible some comparisons between the general method of feeding corn and alfalfa, and the feeding of several other rations. While good weather prevailed for the feeding trials, the work was carried out under unusual disadvantages. The lambs were the poorest possible for such a trial, but buying them was delayed until late in the season and we had to accept such lambs as could then be obtained or delay the trial a year. The better feeder lambs had been sold, and while the shrop crosses, 106 of which were obtained, were fairly good, the 197 small Merino lambs purchased would have been a losing proposition for any buyer. The larger lambs used weighed an average of 48 pounds when obtained, and the smaller Merinos weighed not to exceed 33 pounds when put on feed. The lambs were put in feed lots and given all the alfalfa they would clean up from November 17 to December 5. On that date they were divided into five lots, each lot containing as nearly the same number of lambs of the two classes as possible. The Shropshire grades are designated "large" and the Merinos as "small" lambs throughout the report. The lambs were ear-marked and branded, in order to prevent loss of records by their becoming mixed, if such should happen.

TABLE I. *Lamb Lots on December 5, 1903.*

Lot	Large	Small	Total	Total weight, pounds	Average weight, pounds
I	22	38	60	2260	37.7
II	21	39	60	2370	39.5
III	21	39	60	2332	38.6
IV	21	39	60	2332	28.6
V	21	38	59	2397	40.6

On December 5 all the lambs were placed on a preliminary feeding of oats for nineteen days. The man in charge made two important omissions in carrying out the plans of the experiment. The large and small lambs were not weighed separately on December 5, and none of the lambs were weighed when brought from the range on November 17. The experiment really began, therefore, on December 13, with lambs that had been fed nineteen days on alfalfa and nine days on alfalfa and oats. During these nine days the lambs were given the following amount of feed. Oats were fed to Lot I only three days. No account is taken of the waste hay except to show the amount fed which was not consumed by the lambs:

TABLE II. *Preliminary Feeding.*

Lot	Alfalfa	Waste	Oats	Weight Dec. 13, pounds	Gain in 9 days, pounds
I	785	120	18	2410	150
II	785	111	50	2462	92
III	785	112	50	2442	110
IV	785	110	50	2397	65
V	785	109	50	2365	—32

At this time the separate lots of large and small lambs were weighed, and the weighings were repeated each ten days throughout the experiment, as reported in the tables of weights below.

FEED CONSUMED AND RATIONS.

The pease raised for this experiment were in a field on the south end of the Experiment Farm and about three-fourths of a mile from the feeder's house. About four acres of this

field had been plowed and planted to a crop in 1902, but the balance of the field was native sod broken in the spring of 1903 and planted at the rate of about ninety pounds of pease per acre. The land is somewhat rough, and because of other work occupying the attention of our small force of men, this field of pease was not irrigated at all. Four varieties of pease, the White Canadian, Green Canadian, Golden Vine, and Mexican, were sown in approximately equal amounts. Because of the unfavorable conditions, making comparisons between the varieties would be of little value. The Golden Vine Pease made smaller growth than the other varieties and matured earlier. The Mexican Pease were obtained from the San Luis Valley in Colorado and the seed was badly mixed with weed seeds. A part of this seed was planted before it was screened to remove the weeds, and it was found necessary to mow this part of the crop in order to prevent the weeds from ripening their seed.

The pease on eleven and six-tenths acres matured about one-third of a crop. The total yield was approximately 2,117.5 pounds per acre, of which 1,380.5 pounds were vines or pea straw and 737 pounds were grain. Those vines which made the best growth reached a height of about two feet, while on good land and with proper irrigation the vines in this locality will ordinarily reach a length of from six to eight feet. We estimate the total amount of feed on this land as the feed furnished the lambs, but are unable to estimate the amount which was actually consumed by them. A mistake which is often made in pasturing lambs on pease in the West is that they are allowed to run over the whole field, tramping out and destroying a large part of the feed. This condition puts before the lambs a maximum amount of feed at the first part of the feeding period, when they should be started with a limited supply, and causes them to have the poorest amount of feed and take the most effort to get it in the finishing feeding period, when the food condition should be the best. To prevent this general reversal of the correct order, it is necessary to divide the field

LAMBS IN LOT I, DECEMBER 13, TURNED ON FIELD PEASE.
Shows Amount of Pease on Ground.

LAMBS IN LOT I ON FIELD PEASE.
Note how pease are cleaned up and improved condition of lambs.

by fencing off small portions and turn the lambs into new sections as required.

In this experiment the lambs were fenced on a small portion of the field at a time and kept there until the pease were eaten off as closely as possible without allowing the lambs to suffer for a sufficient quantity of food. Sheep are very close feeders, and, even after shelling out the pease by tramping over them, they will pick them up surprisingly clean. There was a large amount of wind during the winter and a considerable quantity of the pease blew away, more than would probably have been wasted had there been a sufficient stand and growth of vines to mat and hold them together, as ordinarily occurs when a good crop is obtained. It is not possible to tell what portion of the crop was wasted, but by comparing with the foods consumed in other rations, it is probable that not more than sixty or seventy per cent. of the total crop was consumed.

Table III gives the amount of food furnished to each lot of lambs during the ten-day periods. We can only give the amount given to Lot I for the entire time of feeding. All the turnips and concentrates were eaten by the lambs, and there was a waste of alfalfa fed amounting to from four to ten per cent. The cost would be figured on the basis of the amount of food given the lambs, whether it was eaten or wasted, and should be so figured in comparing any of the lots fed alfalfa with Lot I fed on the pease.

WEIGHTS AND GAINS.

Tables IV to VIII, inclusive, give the numbers of large and small lambs in each lot and the weights, total gains, and average gain per head for each of the ten-day periods, and table IX gives a comparison of the gains made by each lot. A little study of table IX shows that the lambs in Lot I which were pastured on pease did remarkably well under the conditions when compared with the lots which were fed other

rations in a more extensive way. The lambs in Lot I made a gain of 24.9 pounds per head, which is only second to the lambs in Lot III, which were fed the best ration we could devise, their gain being 27.2 pounds. The lambs of Lot I made a better gain than did the lambs in Lot IV, which were fed alfalfa and corn in the usual method of Western feeding. Also throughout the experiment we have attempted to compare the feeding of the large Shropshire cross lambs with the smaller Merinoes in each lot, and table IX shows that in general the Shropshire grades made better gains than did the Merinoes. In Lots IV and V they actually gained less, but the average of all the lots gives them a little more than three pounds advantage.

In table X is shown the total feed given to each lot of lambs, the amount of feed which it took to produce one hundred pounds gain, and the nutritive ratio of each of the rations fed. The comparison here of Lot I is of little value, for the reason stated in discussing the amount of waste probable with the lambs on the pease, but the amount of food for one hundred pounds gain is comparable for the other lots and gives some indication of the comparative economy of the different rations fed.

Table XI shows the total amount of protein and carbohydrates and fat given to each lot of lambs for one hundred pounds of gain.

No attempt will be made in this report to discuss the cost and profit of feeding the different lots of lambs or to go into the other details of the experiment, as a bulletin giving the general results will be published during the winter.

FAT LAMB FROM LOT III,
March 14, 1904.
Fed Alfalfa, Turnips, Corn and Oil Meal.

FAT LAMB FROM LOT III,
March 14, 1904.
Had shed his wool, evidently from over-feed.

LAMBS IN LOT IV FED ALFALFA AND CORN, MARCH 14, 1904.

TABLE III. *Feed of Lambs by Ten-Day Periods.*

	Lot I	Lot II			Lot III				Lot IV		Lot V			
	Pease in field	Alfalfa	Turnips	Oil meal	Alfalfa	Turnips	Corn	Oil meal	Alfalfa	Corn	Alfalfa	Barley	Wheat	Oil meal
First 10 days	. . .	950	285	38	895	285	76	17	935	76	910	76	. .	. .
Second 10 days	. . .	1060	436	80	845	380	160	30	895	160	855	. .	134	. .
Third 10 days	. . .	1100	600	60	785	600	320	60	920	200	940	200	. .	. .
Fourth 10 days	. . .	1075	600	60	725	600	320	60	880	320	975	. .	200	. .
Fifth 10 days	. . .	1045	600	60	750	600	320	60	745	500	905	320	. .	. .
Sixth 10 days	. . .	1100	600	60	700	450	400	100	675	574	860	. .	400	. .
Seventh 10 days	. . .	1155	600	60	610	. .	500	100	610	520	710	473	. .	30
Eighth 10 days	. . .	1140	600	60	655	. .	555	100	795	344	785	. .	480	30
Ninth 10 days	. . .	975	770	76	700	. .	600	100	765	526	765	500	. .	30
Tenth 10 days	. . .	965	900	113	700	. .	600	100	685	608	685	. .	500	30
Total	*24563	10565	5991	667	7365	2915	3851	727	7905	3828	8390	1569	1714	120

*8,550 lbs. pease; 16,013 lbs. pea straw.

TABLE IV. *Lot I—Weights and Gains.*

	Large Lambs					Small Lambs					Large and Small Lambs		
	Initial weight	Closing weight	Gain	No. of lambs	Average Gain	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Gain	No. of lambs	Average gain
First 10 days	1058	1085	27	22	1.23	1352	1400	48	38	1.26	75	60	1.25
Second 10 days	1085	1100	15	22	.68	1400	1407	7	38	.18	22	60	.37
Third 10 days	1100	1142	42	22	1.91	1407	1465	58	38	1.53	100	60	1.67
Fourth 10 days	1142	1230	88	22	4.00	1465	1625	160	38	4.21	248	60	4.13
Fifth 10 days	1230	1345	115	22	5 23	1625	1810	185	38	4.87	300	60	5.00
Sixth 10 days	1345	1375	30	22	1.36	1810	1860	50	38	1.32	80	60	1.33
Seventh 10 days	1375	1465	90	22	4 00	1860	2017	157	38	4.13	247	60	4.12
Eighth 10 days	1465	1565	100	22	4.55	2017	2192	175	38	4.61	275	60	4.58
Ninth 10 days	1565	1716	151	22	6.86	2140†	2178	38	37	1.03	189	59	3.20
Tenth 10 days	1645*	1609	−36	21	−1.71	2120‡	2111	−9	36	−.25	−45	57	−.79
			622		28.20			869			1491		24.9

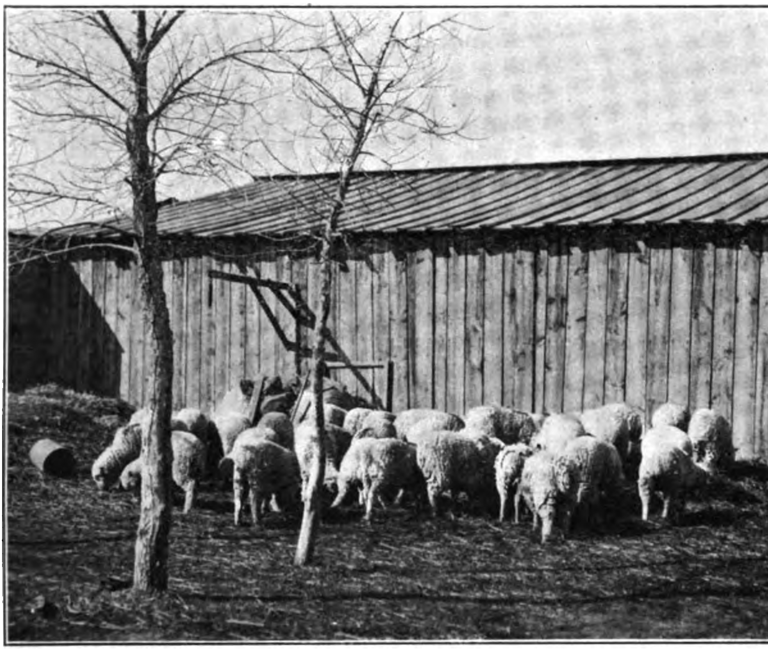
*1 died; wt. 71 lbs. †1 died; wt. 52 lbs. ‡1 died; wt. 58 lbs.

TABLE V. *Lot II—Weights and Gains.*

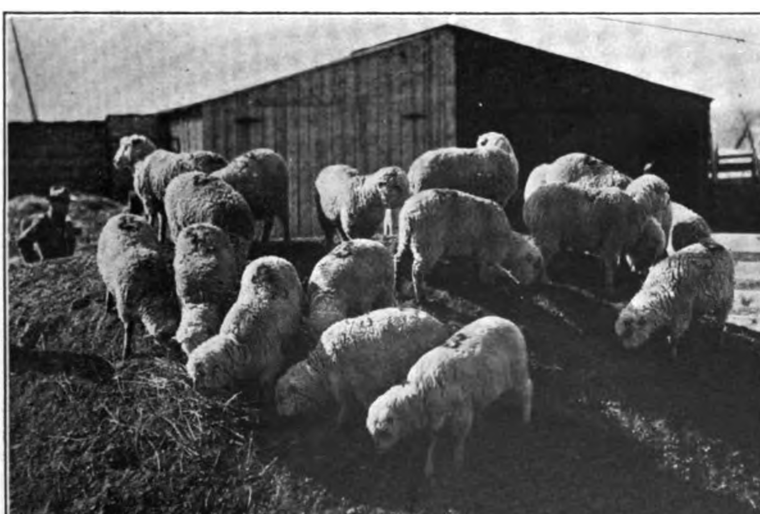
	Large Lambs					Small Lambs					Large and Small Lambs		
	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Gain	No. of lambs	Average gain
First 10 days	1047	1086	39	21	1.86	1415	1450	35	39	.90	74	60	1.23
Second 10 days	1086	1157	71	21	3.38	1450	1633	183	39	4.69	254	60	4.23
Third 10 days	1157	1200	43	21	2.05	1633	1710	77	39	1.97	120	60	2.00
Fourth 10 days	1200	1245	45	21	2.14	1710	1743	33	39	.85	78	60	1.30
Fifth 10 days	1245	1289	44	21	2.10	1743	1773	30	39	.77	74	60	1.23
Sixth 10 days	1289	1351	62	21	2.95	1773	1862	89	39	2.28	151	60	2.52
Seventh 10 days	1351	1392	41	21	1.95	1862	1970	108	39	2.77	149	60	2.48
Eighth 10 days	1392	1506	114	21	5.43	1970	2043	73	39	1.87	187	60	3.12
Ninth 10 days	1506	1484	−22	21	−1.05	2043	1937	−106	39	−2.72	−128	60	−2.13
Tenth 10 days	1484	1495	11	21	.52	1937	2086	149	39	3.82	160	60	2.67
			448		21.3			671		17.2	1119		18.7

TABLE VI. *Lot III—Weights and Gains.*

DATE	Large Lambs					Small Lambs					Large and Small Lambs		
	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Gain	No. of lambs	Average gain
First 10 days	1022	1032	10	21	.48	1420	1395	−25	39	−.64	−15	60	−.25
Second 10 days	1032	1129	97	21	4.62	1395	1590	195	39	5.00	292	60	4.85
Third 10 days	1129	1255	126	21	6.00	1590	1618	28	39	.72	154	60	2.57
Fourth 10 days	1255	1313	58	21	2.76	1618	1800	182	39	4.67	240	60	4.00
Fifth 10 days	1313	1409	96	21	4.57	1800	1883	83	39	2.13	179	60	2.98
Sixth 10 days	1409	1402	−7	21	−.33	1883	1927	44	39	1.13	37	60	.62
Seventh 10 days	1402	1465	63	21	3.00	1927	1974	47	39	1.21	410	60	6.83
Eighth 10 days	1465	1492	27	21	1.29	1974	2188	214	39	5.49	−59	60	−.98
Ninth 10 days	1492	1604	112	21	5.33	2188	2197	9	39	.23	121	60	2.02
Tenth 10 days	1604	1699	95	21	4.52	2197	2373	176	39	4.51	271	60	4.52
			677		32.24			953		24.45	1630		27.2



LAMBS IN LOT V FED ALFALFA, WHEAT AND BARLEY, MARCH 14, 1904.



LARGE LAMBS OF LOT V, MARCH 14, 1904.

TABLE VII. *Lot IV—Weights and Gains.*

DATE	Large Lambs					Small Lambs					Large and Small Lambs		
	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Gain	No. of lambs	Average gain
First 10 days	1041	1062	21	21	1.00	1356	1455	99	39	2.54	120	60	2.00
Second 10 days	1062	1065	3	21	.14	1455	1503	48	39	1.23	51	60	.85
Third 10 days	1065	1107	42	21	2.00	1472*	1522	50	38	1.31	92	59	1.56
Fourth 10 days	1107	1155	48	21	2.29	1522	1635	113	38	2.94	161	59	2.73
Fifth 10 days	1155	1255	100	21	4.76	1635	1795	160	38	4.21	260	59	4.41
Sixth 10 days	1255	1285	30	21	1.43	1795	1839	44	38	1.16	74	59	1.25
Seventh 10 days	1285	1327	42	21	2.00	1780†	1789	9	36	.25	51	57	.89
Eighth 10 days	1327	1375	48	21	2.29	1680‡	1740	60	34	1.76	108	55	1.96
Ninth 10 days	1375	1460	85	21	4.05	1740	1920	180	34	5.29	265	55	4.82
Tenth 10 days	1460	1522	62	21	2.95	1920	2007	87	34	2.56	149	55	2.71
			481		22.91			850		23.25	1331		23.2

*1 died; wt. 31 lbs. †2 died; wts. 30 lbs. and 29 lbs. ‡2 died; wts. 62 lbs. and 47 lbs.

TABLE VIII. *Lot V—Weights and Gains.*

DATE	Large Lambs					Small Lambs					Large and Small Lambs		
	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Initial weight	Closing weight	Gain	No. of lambs	Average gain	Gain	No. of lambs	Average gain
First 10 days	990	998	8	21	.38	1375	1407	32	38	.84	40	59	.68
Second 10 days	998	1052	54	21	2.57	1407	1489	82	38	2.16	136	59	2.31
Third 10 days	1052	1100	48	21	2.29	1472*	1542	70	37	1.89	118	58	2.03
Fourth 10 days	1100	1127	27	21	1.29	1542	1557	15	37	.41	42	58	.72
Fifth 10 days	1127	1150	23	21	1.10	1557	1665	108	37	2.92	131	58	2.26
Sixth 10 days	1150	1190	40	21	1.90	1665	1695	30	37	.81	70	58	1.21
Seventh 10 days	1190	1235	45	21	2.14	1695	1845	150	37	4.05	195	58	3.36
Eighth 10 days	1235	1277	42	21	2.00	1845	1912	67	37	1.81	109	58	1.88
Ninth 10 days	1277	1365	88	21	4.19	1912	2050	138	37	3.73	226	58	3.90
Tenth 10 days	1365	1395	30	21	1.43	2050	2105	55	37	1.49	85	58	1.47
			405		19.29			747		20.11	1152		19.8

*1 died; wt. 17 lbs.

TABLE IX. *Comparison of Average Gains.*

Lot	FEED	Average gain per head: All lambs in lot	Average gain per head: Large lambs	Average gain per head: Small lambs	Difference per head in favor of large lambs
I. . .	Field Pease.	24.9	28.2	22.9	5.3
II . .	Alfalfa, Turnips, Oil Meal	18.7	21.3	17.2	4.1
III. .	Alfalfa, Turnips, Corn, Oil Meal	27.2	32.2	24.5	7.7
IV. .	Alfalfa, Corn.	23.2	22.9	23.3	—.4
V . .	Alfalfa, Barley, Wheat, Oil Meal.	19.8	19.3	20.1	—.8

TABLE X. *Feed for Gain.*

LOT	Total gain, lbs.	Total feed, lbs.: Pease	Alfalfa	Turnips	Corn	Barley	Wheat	Oil meal	Feed for 100 lbs. gain: Pease	Alfalfa	Turnips	Corn	Barley	Wheat	Oil meal	Nutritive ratio
I.	1491	24563	. .	. .	. .	. .	. .	. .	1648	. .	. .	. .	. .	. .	. .	1 : 4.7
II	1119	. . .	10565	5991	. .	. .	. .	667	. .	944	535	. .	. .	. .	60	1 : 3.73
III.	1630	. . .	7365	2915	3851	. .	. .	727	. .	452	179	236	. .	. .	44	1 : 4.94
IV.	1331	. . .	7905	. .	3828	. .	. .	. .	. .	594	. .	288	. .	. .	. .	1 : 5.37
V.	1152	. . .	8390	. .	. .	1569	1714	120	. .	728	. .	. .	137	149	10	1 : 4.70

TABLE XI. *Lbs. Digestible Nutrients for 100 lbs. Gain.*

	Protein	Carbohydrates and fat
Lot I.	143	665
Lot II	126	472
Lot III.	83	404
Lot IV.	87	472
Lot V	110	518

OUTLINE PLANS, DIRECTOR AND PROFESSOR OF AGRICULTURE.

1904-05.

I. CROPPING AND SOILS.

(*a*) General Crops—Wheat, Barley, and Oats for seed and feed.

(*b*) Field Pease.

(c) Forage Crops—Alfalfa, Grasses, etc. Studies with White Sweet Clover. Ranch Studies.

(*d*) Management of Soils. Reclamation Co-operation.

II. ANIMAL INDUSTRY.

(*a*) Feeding Experiments with Lambs.

(*b*) Feeding Experiments with Steers.

(*c*) Feeding Experiments with Other Animals.

(*d*) Breeding Experiments.

(*e*) Digestion Experiments in Co-operation with Chemist.

(*f*) Poultry.

(*g*) Gathering Data and Photographs of the Stock Industry as Found in the State.

III. HORTICULTURE AND AGROSTOLOGY.

(*a*) Notes on Fruits.

(*b*) Vegetables—Garden.

(*c*) Flowers for Decoration.

(*d*) Grass Experiments.

IV. IRRIGATION.

1. Irrigation Practice.

(*a*) Duty of Water.

(*b*) Amount of Water to Produce Maximum Crops.

2. Reclamation—Drainage.

3. Co-operation—Office of Experiment Stations.

V. MISCELLANEOUS.

(*a*) Publications: Regular Bulletins; Press Bulletins; Monthly Ranchman's Reminder; Articles for Agricultural Press; Articles for Local Papers; and Annual Report.

(*b*) Records and Photographs.

(*c*) Short Course.

(*d*) Farmers' Institutes.

(e) Agricultural Propaganda. Correspondence.

Meteorology

SUMMARY FOR 1903.

Highest temperature, 84 degrees, June 28, July 26, August 3, 5, 17, and 21.

Lowest temperature, —26 degrees, February 15.

Mean temperature for year, 40.6 degrees.

Greatest daily range of temperature, 45 degrees, May 18.

Lowest daily range of temperature, 5 degrees, April 2.

Mean daily range of temperature, 24.8 degrees.

Mean soil temperatures, three inches, 44.2 degrees; six inches, 43.6 degrees; twelve inches, 43.6 degrees; twenty-four inches, 43.6 degrees; thirty-six inches, 42.3 degrees; seventy-two inches, 44.1 degrees.

Mean relative humidity for year, 60.2 degrees.

Lowest relative humidity, 11 degrees, July 2.

Highest dew-point, 55 degrees, August 23.

Lowest dew-point, —43 degrees, February 15.

Mean dew-point, 25.7 degrees.

Highest barometer, 23.353, June 6.

Lowest barometer, 22.589, January 28.

Mean barometer, 23.037.

Highest monthly precipitation, 2.39 inches, September.

Lowest monthly precipitation, .7 inch, December.

Greatest amount of precipitation in one storm, 1.59 inches, September 11-14.

Total precipitation for year, 10.33 inches.

Mean precipitation for ten years preceding 1904, 9.60 inches.

Evaporation (from June 5 to October 31), 23.11 inches.

Greatest monthly evaporation, 6.93 inches, July.

Prevailing direction of wind, west-southwest.
Greatest velocity of wind, 75 miles per hour, May 5.
Greatest number of miles in one day, 628, January 6.
Least number of miles in one day, 64, February 14 and 26.
Greatest number of miles in one month, 10,434, December.
Least number of miles in one month, 6,764, August.
Average monthly distance, 8,337 miles.
Average daily distance, 274 miles.
Average hourly distance, 11.4 miles.
Total number of miles for year, 99,971.
Number of clear days, 217.
Number of partly cloudy days, 106.
Number of cloudy days, 42.
Number of days on which .01 inch or more of precipitation fell, 73.

PRECIPITATION TOTALS FOR PAST TEN YEARS.

1891	13.92	1895	11.15	1900	8.53
1892	12.73	1896	10.75	1901	8.52
1893	3.84	1897	11.99	1902	7.65
1894	7.63	1898	7.63	1903	10.33
		1899	11.84		

Report of the Botanist.

AVEN NELSON.

The work of the Botanical Department during the past year has been quite varied. Routine work (correspondence and miscellaneous duties) has claimed much time.

The definite problems that have had attention are much the same as those that have interested the department for several years past. Each year sees some progress made in one or more lines. The questions are of such a nature that one can really only hope for partial or progress reports. Publication is necessarily always only on some one phase of the work in hand. That this must be so is easily seen by reference to the outline of work as planned for continuation during the ensuing year (printed below).

One bulletin was issued, with the assistance of Mr. Elias Nelson, in the series treating the genera of agriculturally important grasses (No. 59, The Wheat-Grasses of Wyoming).

Forage problems were discussed before some of the sessions of the Short Course.

Some pathological plant specimens were secured and prepared for the collective exhibit of the Colleges and Stations at the Louisiana Purchase Exposition.

Various technical papers dealing with the flora of the state were published in the botanical journals.

The outline of work as planned for the year follows:

WYOMING EXPERIMENT STATION—PLANS OF WORK.

(Botanical Department, 1904-1905.)

I. FORAGE INVESTIGATIONS.—The publication (if possible) of the third bulletin in the series on the important genera of native grasses.

II. FURTHER STUDY OF THE BOTANICAL PHASES OF HOME MAKING.—A third bulletin in the series is contemplated, possibly under the title, "Making a Home Versus Staying on the Place."

III. STUDY OF THE FOREST FLORA OF THE STATE.—On account of the continued and increasing demand for Bulletin No. 40 (now long out of print), "The Trees of Wyoming and How to Know Them," it may be well to revise and republish that number, enlarging that portion of it which deals with our forest area, forest reserves and forestry methods.

IV. NATIVE FRUITS.—Much information on the native fruits of the state has been accumulated. Since many of the species already have a considerable domestic use and seem promising under cultivation, it would be well to call attention to these, in order that they may find more general introduction into the home garden and orchard.

V. FUNGICIDES AND INSECTICIDES.—On account of the relative freedom from injurious fungi and insects in this state, nothing has been published on these subjects for more than a decade. On account of the important increase in fruit growing and gardening, there seems to be now a real demand which should be met by an "information bulletin" on these subjects.

VI. POISONOUS PLANTS.—Here is a subject of much interest and importance. The reputed poisonous plants may easily be described and figured, but the isolating of the poisonous properties and the prescribing of adequate remedies have proven most elusive chemical problems. Information in regard to this class of plants from the botanical side is now at hand.

Report of Chemist.

The work of the past year has been somewhat retarded by the change in the head of the department. Dr. Slosson received a leave of absence about the first of the calendar year, and his position has since been temporarily filled by the writer. Much time has necessarily been consumed in becoming familiar with the work being carried on in the department. The plans of Dr. Slosson are being carried out for the year as far as possible with little change.

Besides the usual routine analyses and correspondence, the time of the Chemist has been chiefly occupied with the analysis of food sold in Wyoming. Several hundred analyses have been completed and reports sent to those who had taken the trouble to collect the samples, and when evidences of adulteration were found the dealers, and in many cases the manufacturers, were notified. Instructions were always sent with the advice that the reports of analyses be turned over to the health officer in the county where the samples were taken.

Quite a deep interest has been manifested by dealers in the state and by parties shipping foods into the state; and already it is evident that the grade of foods retailed is improving. A number of foods have been debarred from the state because of unlawful practices on the part of the manufacturers.

In addition to the continuation of the work on the adulteration of foods, it is proposed during the following year to make investigation along the following lines:

ALKALI STUDIES.—Investigations of the effect of alkali upon seeds under various conditions. This is to be a continuation of the work carried on in this department by the former Chemist.

DIGESTION EXPERIMENTS.—Practically no investigations of importance have been carried on at this altitude along this line.

It is proposed to make the experiments with sheep, using native grasses and other feeding material, and determine by analyses the food values of the different materials used. Every stockman knows the value of data along this line. This work is to be carried on in conjunction with the Director.

FORAGE PLANT ANALYSIS.—This work will necessarily have to be carried on in conjunction with the digestion experiments, but it is proposed to start this work as a foundation for future investigations, and it is the intention to go deeper into the problem than the digestive experiments would require.

SEEPAGE WATER STUDIES.—A large part of the water used for irrigation is in all probability returned by seepage to the parent stream and used over and over again. It is very probable that the water undergoes a change in passing through the soil. Whether this change is enough to affect the usefulness of the water for irrigation purposes is problematical.

A convenient, well lighted room was fitted up in the Science Hall for a research laboratory last year. Some new equipment has been put in this year, which will be followed by other improvements.

HENRY G. KNIGHT,
Professor of Chemistry.

PLANS OF WORK, DEPARTMENT OF CHEMISTRY.

I. Alkali Studies VI.
II. Digestion Experiments in co-operation with the Department of Agriculture.
III. Forage Plant Analyses.
IV. Pure Food Investigations.
V. Studies of Seepage Waters.

Report of the Irrigation Engineer.

The work in irrigation during the past fiscal year has been a continuation of the duty of water studies which have for many years been a feature of Station work, the completion and report of the special work undertaken during the season of 1903, and the planning and executon of the work to be carried on during the irrigation season of 1904. These various lines of work, together with such teaching as the writer has done during the past school year, have kept his time fully occupied.

With regard to the work carried on the past two seasons and that planned for the present season, we think we are safe in saying that it will be of more interest and value than the merely local work which has heretofore been done. The usual duty of water measurements, while of much value as a basis for generalization, offer results of little immediate interest outside of the locality in which they are made. While, therefore, still continuing this work, and, in addition, making some investigations into the approximate water requirement of crops upon the Station Farm, we have, so far as has been possible, sought to detach ourselves from the territory immediately adjacent to Laramie and carry on lines of investigation in other parts of the state. No funds being available for independent work of this character, we have been fortunate in being able to co-operate with the federal bureaus interested. During the season of 1903 the Office of Irrigation Investigations of the U. S. Department of Agriculture made a study of the effect of seepage and return waters upon rights vested in the flow of the North and South Platte Rivers and tributaries. The portion of the work on the Laramie River was assigned to

this Station, and from the measurements made results were obtained which have been made the basis of Bulletin No. 61, issued in March. Together with these results are also reported seepage measurements made upon several canals diverting water from the Laramie River.

While in a general way it was known that unless a high percentage of the water diverted from the stream eventually returned to it again, a large area of land along the river would be without water during the late summer months, still the facts were not definitely known. The measurements of last summer showed that throughout nearly the entire length of the river a considerable amount of water was reaching it by invisible inflow; in certain sections the amounts of water returning in this manner exceeding the entire flow of the stream. The most notable instance of this was found between the point at which the river leaves the Laramie hills and its junction with the North Platte. In this length of about fifty-two miles tributary streams were found contributing 4.6 cubic feet per second, and the river, upon leaving the mountains, had a flow of 5.9 second feet. Thus 10.5 second feet comprised the entire supply for about twenty ranches, the actual diversions for the irrigation of which amounted at the time to 25.9 second feet, or about two and one-half times as much as the visible supply.

The canals investigated were the Pioneer Canal, near Laramie; the No. 3 Canal at Wheatland, and the Highline Canal and Divide Ditch on the headwaters of the Laramie. These canals are all losing a surprisingly large amount of water, it being found that in one distance of 3.4 miles along the Pioneer Canal enough water was being lost under the combined influence of seepage and evaporation to irrigate, if applied in the usual way, approximately 1,000 acres of land. From the other canals the losses were found to be on the average as follows:

Two cubic feet per second per mile on the No. 3 Canal, Wyoming Development Company, and 2.88, 2.23, 0.32 on the Highline Canal, Divide Ditch and Sodergreen Ditch, respect-

ively. Although, perhaps, water is not sufficiently valuable at present to justify any large expense in reducing these losses, the results will show the necessity of some remedial measures and at least make known to canal operators that such conditions actually do exist.

As elsewhere stated, the duty of water measurements are being continued and experiments are also being carried on with a view of determining the best amount of water with which to irrigate. During the past season all water applied to the farm was measured as in previous years, the weirs and automatic depth registers being maintained as usual. To check the registers, we have prepared a set of blank notes to be kept by the irrigator. As field work occupied a large part of our time during the summer, the care of the registers and notes has fallen mainly upon Mr. Farrar, his work being entirely satisfactory.

The results obtained last season in the irrigation of potatoes with a view to determining their water requirements check in a most interesting manner the results of the past three years, as shown in the tables below.

YIELD IN POUNDS PER ACRE INCH OF WATER RECEIVED.

YEAR	DEPTH OF WATER RECEIVED BY LAND PER YEAR IN INCHES.						
	6 12	12-15	15 18	18 24	24 30	30-36	Over 36
1900	105	168	191	. . .	. . .	. . .	. . .
1901	. . .	. . .	249	. . .	135	. . .	96
1902 (a)	410	385	710	210 265	186	151	121 105 77
1902 (b)	348	314	267	178 229	132	69	63
1903	. . .	486 338	556	312	. . .	. . .	. . .
Average	287	338	395	239	151	110	92

TOTAL YIELD IN POUNDS PER ACRE.

YEAR	DEPTH OF WATER RECEIVED BY LAND PER YEAR IN INCHES						
	6-12	12-15	15-18	18-24	24-30	30-36	Over 36
1900	1176	2330	3050	....	....	....	...
1901	....	....	3956	....	3332	....	5432
1902 (a)	4220	5110	11530	5110 4920	4700	4730	4540 3790
1902 (b)	3590	4175	4340	4090 4420	3350	2170	2340
1903	....	4830	6960 9640	7270	....	....	...
Average	2985	4111	6584	5162	3794	3450	4025

(a) Two irrigations. (b) One irrigation.

The first of these tables shows the best practice measured by the value of a unit volume of water used; the second shows the amount of water to use to produce the largest crop. By these tables it seems evident that if potatoes can secure between fifteen and eighteen inches in depth of water during the year the best results will be secured not only from the standpoint of value of the water, but also considering the size of the crop. As to quality, it is unnecessary to state that the potatoes receiving the smaller amounts of water had less moisture content than the others.

These experiments are of such a nature, however, that generalization will not be possible until a much larger mass of data than that at present on hand is secured. This will require a repetition of the experiments through a series of several more years, in order that variations due to seasons may be eliminated.

We now have a series of results from general duty of water measurements extending back almost unbroken for a period of eleven years. These results are being collected and compared, and if considered of sufficient popular interest will be published as a bulletin. The duties determined on such crops as were grown last season are arranged in tabular form below, together with averages on all crops regularly grown for the past ten years.

DEPTH OF WATER RECEIVED BY CROP DURING SEASON IN FEET AND YIELD IN POUNDS PER ACRE FOOT.

	Alfalfa		Barley		Oats		Potatoes		Wheat	
	Depth of irrigation	Yield	Depth	Yield	Depth	Yield	Depth	Yield	Depth	Yield
1903	1.96	2900	. . . .	. . .	1.17	1480	1.33	3955	. . . .	. .
Average previous eleven years.	2.58	3260	1.97	555	2.28	606	1.12	6434	1.97	648

The work to be undertaken the present season comprises the usual duty of water measurements upon the Station Farm, co-operative work with the Reclamation Service of the U. S. Geological Survey and the Office of Irrigation Investigations of the U. S. Department of Agriculture. With the former we are co-operating in a study of irrigation conditions on the North Platte River. Before estimating upon the acreage possible to redeem by the waters of this river, the engineers desired to have some knowledge from actual existing conditions as to the amount of water to allow per acre. The projects under consideration involve a considerable body of Wyoming land, but as irrigation development along the river in Wyoming is merely in a rudimentary state, the only feasible locality for the study was to be found in Nebraska. The locality under study extends along the river from the Wyoming line thirty miles into Nebraska. One of the canals is diverted in Wyoming. Climatic and soil conditions are representative of a large portion of the lands under the project in Wyoming, and it is thought that the results obtained by the study, in addition to being of immediate value in the design of the system, will be applicable to similar localities on the Wyoming side of the state line.

The co-operation with the Office of Irrigation Investigations consists of a practical experiment in the drainage and reclamation of twenty acres of alkali land upon the penitentiary farm near Laramie. Various schemes will be resorted to in the effort to determine the most feasble and economical method, and the experiment will extend over a period of five years.

Report of Assistant in Horticulture and Agrostology.

During the summer of 1903 notes were taken on the various crops grown on the farm, and observations were made on the field crops, the permanent grass and forage plats, the grass plats sown in the spring, the range plats, the varieties of field pease grown for sheep pasture, and certain varieties of vegetables tested.

Samples of the different forage crops and grasses growing on the farm were taken and prepared for exhibition at the State Fair, held at Sheridan. Bundles of native grasses were also secured in the vicinity of Laramie, and a special trip was made in company with the Botanist up the Laramie River to collect samples.

The grain varieties grown for exhibition were rogued, and when mature head and straw bundles were taken and prepared for exhibition at Sheridan, as well as for the Louisiana Purchase Exposition.

In October I accompanied the Director to Sheridan and assisted in the installation of the exhibit of Albany County and of the Experiment Station. At the close of the fair we took charge of the agricultural products exhibited at Sheridan and shipped them to Laramie, to be stored and prepared for the Louisiana Purchase Exposition. On returning to Laramie, two months were occupied in the preparation of these products for exhibition. In the spring five weeks were spent in St. Louis, where I assisted in the installation of the Wyoming agricultural exhibit. All this work, being outside the work of the Experiment Station, was paid for by the Wyoming World's Fair Commission.

A report on the cultivation of Wheat-Grasses on the Experiment Farm was prepared and published as a part of Bul-

Matrimony Vine or Box Thorn—A Laramie Home.

letin No. 59*, together with popular descriptions of the Wyoming species.

Typical heads of the varieties of barley and oats grown in 1896, 1897, and 1898 have been mounted on "bristol boards" for purposes of study and in order that photographs may be taken for illustrations.

Various bedding plants suited to our climatic conditions have been grown in the greenhouse for use on the University Campus. Strong, healthy plants were produced by the use of leaf-mold and fresh soil from the hills, with no admixture of any animal manure.

A vegetable garden has been planted on the farm this spring. The varieties grown are such as in our experience have been found to do well at this altitude, while some new varieties are also being tested.

Observations on the growth of the grasses and forage plants have been resumed and will be continued throughout the season.

ORNAMENTAL SHRUBS.

During the year there have been a number of inquiries in regard to ornamental shrubs and herbaceous perennials suitable for home decoration at higher altitudes in the state. In order to better meet the demand for information along this line, efforts have been made this spring to observe what kinds have persisted from year to year on private grounds in Laramie. Since the altitude of this city is somewhat over 7,000 feet, those varieties which grow here would be suitable for cultivation throughout the state. About a dozen cultivated shrubs appear to be hardy at this altitude and do quite well in Laramie, especially in protected situations on city lots. The following have been observed in and about the city:

LILACS (*Syringa vulgaris*).—Many fine bushes flowering profusely in June are found in the city.

MATRIMONY VINE OR BOX THORN (*Lycium halimifo-*

*"The Wheat-Grasses of Wyoming," by Aven Nelson and Elias Nelson, November, 1903

lium).—This is a common shrub in Laramie, often erroneously called Jasamine. It is suitable for clambering on walls, trellises, and fences. It is very hardy and easy to start from cuttings or suckers.

ROSES.—Most cultivated roses planted at Laramie winterkill. Some, however, have persisted and flowered in sheltered situations. The Yellow Harrison Rose has been observed in several places in the city. The Yellow Rambler, Maiden's Blush, and Sweetbrier also do fairly well here. There can be no doubt but that many varieties of hardy roses would succeed at this altitude. Madame Plantier, White Harrison, Snowlight, Empress of the North, and Rosa Majalis fl. pl. are varieties which would probably succeed.

YELLOW FLOWERING CURRANT (*Ribes longiflorum*).—This is perfectly hardy, flowers profusely in spring and makes a luxuriant growth in rich soil. Though procurable from nurserymen, it may be secured where growing wild, as it is very common in the state.

TARTARIAN BUSH HONEYSUCKLE (*Lonicera tartarica*).—Perfectly hardy at this altitude. Fine specimens may be seen in several places in the city.

BLUE BUSH HONEYSUCKLE (*Lonicera caerulea*).—A specimen of this shrub has persisted from year to year in an exposed situation on the Experiment Farm.

COMMON BARBERRY (*Berberis vulgaris*).—A number of bushes have persisted for about fifteen years on the University Campus. They have been killed back more or less repeatedly, but have grown up again from the roots. In more protected places it would probably do better.

SIBERIAN PEA-BUSH (*Caragana pygmaea*).—A low, spreading shrub with a profusion of yellow flowers in spring. It is quite hardy, one bush having withstood our severe winters on the Experiment Farm.

SIBERIAN PEA-TREE (*Caragana arborescens*).—A large shrub or small tree, with graceful foliage and yellow flowers.

Two specimens set out in 1903 on Mr. Ivinson's grounds are alive and doing well this season.

FLOWERING ALMOND (*Prunus Japonica*).—This is another shrub which has lived from year to year on the Experiment Farm.

Besides the above named shrubs which may be secured from nurserymen, the following natives are grown in the city:

Willows (*Salix spp.*).
Western Birch (*Betula fontinalis*).
Paper-leaf Alder (*Alnus tenuïfolia*).
Western Gooseberry (*Ribes saxosum*).
Squaw Currant (*Ribes cereum*).
Shrubby Cinquefoil (*Dasiphora fruticosa*).
Roses (*Rosa Woodsii* and *R. Fendleri*).
Black Haw (*Crataegus rivularis*).
Rocky Mountain Cherry (*Prunus demissa melanocarpa*).
Buffalo-berry (*Lepargyraea argentea*).
Silver-berry (*Elaeagnus argentea*).
Dogwood (*Cornus stolonifera*).
Rocky Mountain Elder (*Sambucus melanocarpa*).
Service Berry (*Amelanchier alnifolia*).

Some of these are quite desirable shrubs for home decoration. On Mr. Ivinson's grounds there is a particularly fine bush of our native elderberry, which was covered with large, fine trusses of white flowers this spring.

HERBACEOUS PERENNIALS.

A considerable number of hardy herbaceous perennials may be seen in Laramie. Some of them will persist in exposed situations and under the most adverse conditions, while others require a sheltered location and some winter protection. Hardy bulbs, such as tulips and hyacinths, can be grown at Laramie, and Irises do well here. Hollyhocks are hardy here, and peonies have lived through the winter on several private grounds. The following hardy perennials have been observed in the city:

Ribbon Grass or Gardner's Garters (*Phalaris arundinacea variegata*).

Scarlet Lightning or Maltese Cross (*Lychnis fulgens*).

Common Grass Pink or Garden Pink (*Dianthus plumarius*).

Sweet William (*Dianthus barbatus*).

Perennial Blue Larkspur (*Delphinium formosum*).

Bachelor's Buttons (*Ranunculus acries,* a double buttercup).

Common European Columbine (*Aquilegia vulgaris*).

Iceland Poppy (*Papaver nudicaule*).

Bleeding Heart (*Dicentra spectabilis*).

California Rose (*Convolvulus Japonicus*).

Sage (*Salvia officinalis*).

Garden Heliotrope or Common Valerian (*Valeriana officinalis*).

Old Man or Southernwood (*Artemisia Abrotanum*).

Tansy (*Tanacetum vulgare*).

English Daisy (*Bellis perennis*).

Golden Glow (*Rudbeckia laciniata*).

Dougle White Yarrow, "The Pearl" (*Achillea Ptarmica*).

Milfoil or Yarrow (*Achillea millefolium roseum*).

Golden Rod (*Solidago Canadensis*).

Roots of most of these can be secured for planting from dealers in hardy plants, while a few, such as the English Daisy, Perennial Pinks, Sweet William and the Iceland Poppy, are readily grown from seed.

Many native perennials may be transplanted to the home grounds. The following have been observed in Laramie:

Felix fragilis, a beautiful little fern with thin, delicate fronds.

Male Fern (*Dryopteris Felix-mas*).

Western Blue Flag or Iris (*Iris Missouriensis*).

Meadow Rue (*Thalictrum sp.*).

Rocky Mountain Columbine (*Aquilegia caerulea*).

Canada Violet (*Viola canadensis*).
Richardson's Crane's Bill (*Geranium Richardsoni*).
Western Water-leaf (*Hydrophyllum occidentale*).
Siberian Lungwort (*Mertensia Sibirica*).

MUSHROOM CULTURE.

In December Mr. B. M. Duggar, Collaborator in charge of mushroom investigations in the U. S. Department of Agriculture, sent us spawn of two new varieties for trial. Arrangements were made to grow these in the greenhouse. The cultural directions given in Farmer's Bulletin No. 53 were followed as nearly as possible. By January 13th prepared manure was ready for the beds, which were then made under benches in the greenhouse. About three inches of fresh manure was placed directly on the ground and the prepared manure put on top. The fresh manure was used to furnish some heat, as it was feared that the beds might otherwise not remain warm enough. In six days the temperature had fallen to 95 degrees F. in one bed, which was then spawned with the "Bohemia" variety. The other variety, the "Alaska," was put in another bed the following day, the temperature of the manure being 100 degrees F. On January 30 both beds were loamed, and, in order that they might not become too dry, were covered with burlap, which was sprinkled once a day with water to keep the beds moist. As soon as mushrooms began to break through the soil the covering was removed and the beds after that sprinkled with tepid water once a week. During the last ten days of January the mean temperature of the beds was 67.7 degrees F.; during the month of February, 56.9 degrees, and during March, 59.1 degrees. The temperature of the house during the day varied from 54 to 71 degrees. In the night the temperature went down 10 to 15 degrees.

The first Bohemia mushrooms were picked March 10 and the last May 10, after which no more mushrooms appeared. A total of 223 were picked during the sixty-two days. The

first pick of Alaska mushrooms was made on March 28, eighteen days later than that of the Bohemia. The bed of the Alaska variety yielded 252 mushrooms in thirty-one days, or from March 28 to May 13. After that time only an occasional mushroom appeared. The "Alaska" yielded much the larger mushrooms and more of them than the "Bohemia," and, though later in coming into bearing, made quicker growth.

VARIETIES OF VEGETABLES.

As stated in the last report, arrangements were made with the Horticulturist of the U. S. Department of Agriculture for observations on varieties of vegetables grown on the Experiment Farm in 1903. Blanks for notes on pease, radishes, lettuce, and cabbage were furnished by the Department, and notes on these vegetables were taken. The vegetables were all planted on April 29.

PEASE.

Nine varieties were grown. The chief points of interest to gardeners are tabulated below:

VARIETY	First pick	Height, inches	Average number of pods to plant	Length of pod, inches	Average number peas in pod
Burpee's Extra Early	July 22	32	44	2½	6
Alaska	July 22	25	16	2¼	6
Nott's Excelsior	July 22	12	11	2¾	7
Extra Early Premium Gem	Aug. 1	18	19	2¾	6
Burpee's New Extra Early Gradus	Aug. 1	27	13	3	6
Hurst's Reliance	Aug. 11	40	69	3	7
Yorkshire Hero	Aug. 6	32	47	3	6
Kelvedonian	.....	40	...	3	6
Carter's Daisy	.....	20	21	4	8

NOTES ON THE VARIETIES OF PEASE.

BURBEE'S EXTRA EARLY.—Plant 32 inches high, stout, with many branches; total number of joints, 13; joints to first pod, 5; pods scattered on vine; single pods, 28; pairs of pods, 8. Leaves dark green. Stipules large. Flowers

white. Pod 2½ inches long, straight, somewhat pointed-ended, well filled; section round; back creased; surface smooth, dark green; average number of peas in pod, 6. Peas round. A desirable variety, very similar to the Alaska.

ALASKA OR LAXTON'S EARLIEST.—Plant 25 inches high; total number of joints, 13; joints to first pod, 6; pairs of pods, 3; single pods, 10; pods scattered on vine. Leaves dark green. Flowers white. Pod 2¼ inches long, straight, nearly square-ended, dark green, well filled; section round; back creased; surface smooth; average number of peas in pod, 6. Peas round.

NOTT'S EXCELSIOR.—Plant 12 inches high, stout; joints, 10; joints to first pod, 6; single pods, 11; pods clustered at top of vine, maturing quickly and all together. Leaves dark green. Stipules large, washed with white. Flowers white. Pod 2¾ inches long, straight, somewhat pointed-ended, dark green; section round; back creased; surface a little rough; peas crowded, somewhat flattened; average number in pod, 7.

EXTRA EARLY PREMIUM GEM.—Plant 18 inches high, stout; stem mostly single; joints 12; joints to first pod, 4; pairs of pods, 6; single pods, 7; pods scattered on vine. Leaves dark green. Stipules large, washed with white. Flowers white. Pod 2¾ inches long, straight, pointed-ended, dark green; section round; back creased; surface a little rough; peas crowded, somewhat flattened; average number in pod, 6.

BURPEE'S NEW EXTRA EARLY GRADUS.—Plant 27 inches high; joints, 12; joints to first pod, 6; single pods, 13; pods scattered on vine. Leaves large. Stipules large, washed with white. Flowers white. Pod 3 inches long, straight, pointed-ended; section large, round; back creased; surface a little rough; peas well separated, large, round; average number in pod, 6.

HURST'S RELIANCE.—Plant 40 inches high, slender, with many branches; joints, 15; joints to first pod, 8; pairs of pods, 2; single pods, 62; pods scattered on vine. Leaves

large, light green. Stipules washed with white. Flowers white. Pod 3 inches long, straight, somewhat pointed-ended; section large, flattened; back somewhat creased; surface smooth; pod well filled, the peas large, round; average number in pod, 7.

YORKSHIRE HERO.—Plant 32 inches high, stout, with many branches; joints, 19; joints to first pod, 9; pods scattered on vine; pairs of pods, 17; single pods, 13. Leaves large, dark green. Stipules large, somewhat washed with white. Pod 3 inches long, somewhat curved, pointed-ended, well filled; section large; back creased; surface smooth; average number of peas in pod, 6; peas large, round.

KELVEDONIAN.—Plant 40 inches high, somewhat stout; joints, 16; joints to first pod, 10. Leaves large, light green. Stipules large, washed with white. Flower white. Pod 3 inches long, straight, somewhat jointed-ended, well filled; section large, flattened; back creased; surface a little rough; average numebr of peas in pod, 6; peas large, round, thin-skinned.

CARTER'S DAISY.—Plant 20 inches high, stout, with many branches; joints, 15; joints to first pod, 8; pairs of pods, 3; single pods, 15; the pods scattered on vine. Leaves large, dark green. Stipules large. Flowers white. Pod 4 inches long, nearly straight, pointed-ended, dark green; section flattened; back creased; surface smooth, veined; peas well separated, large, round; average number in pod, 8.

RADISHES.

VARIETY	Top	Root		Color	When 10 per cent. marketable	Duration, days
		Shape	Length, inches			
Burpee's Hailstone.	Small	Globular	1	White	June 12	20
Barteldes' Glass	Large	Long	6	Scarlet	June 12	20
Barteldes' Chartier.	Large	Half long	5	Reddish	. . . . .	. . . .
White Strasburg.	Large	Half long	5	White	June 24	20
Long Cardinal.	Medium	Long	6	Scarlet	June 12	20
Long White Vienna	Large	Long	6	White	June 20	25
New White Icicle	Large	Long	6	White	. . . .	. . .
New Earliest White	Small	Olive	1½	White	June 12	20
Burpee's Earliest Scarlet. . . .	Small	Globular	1	Scarlet	. . . . .	. .

NOTES ON THE VARIETIES.

BURPEE'S HAILSTONE.—Top small, spreading. Root flattened or globular, 1 to 2 inches in diameter, white; quality fair; duration short.

BARTELDES' GLASS.—Top large. Root red, 6 inches long, about ¾ inch in diameter; quality good.

BARTELDES' CHARTIER.—Top large. Root half long, 4 to 5 inches in length, about 1 inch in diameter, reddish in color; tip white; quality good. Sent up seed stalks early.

WHITE STRASBURG.—Top large. Root half long, 4 to 5 inches in length, white; quality good; duration about 3 weeks.

LONG CARDINAL.—Top of medium size. Root about 6 inches long, ¾ inch in diameter, scarlet; quality good; duration about 3 weeks.

LONG WHITE VIENNA.—Top large. Root about 6 inches long, ¾ inch in diameter, white; quality good; duration about 3 weeks.

NEW WHITE ICICLE.—Top large. Root about 6 inches long, ¾ inch in diameter, white; quality good.

NEW EARLIEST WHITE.—Top small. Root globular or olive-shaped, about 1½ inches long, white; quality good; duration about 3 weeks.

BURPEE'S EARLIEST SCARLET.—Top small, spreading. Root globular, 1 inch in diameter, scarlet; quality good; duration short.

VARIETIES OF LETTUCE.

BLACK-SEEDED SIMPSON.—Plant of spreading growth, a cutting variety; natural spread, 15 inches; market weight, 12 ounces. Leaf 9 inches long, 8½ inches wide, roundish, thin, stiff, crumpled and blistered, with large veins, yellowish green; margins serrate; border frilled. Tender, sweet and crisp. A desirable variety, very similar to the Morse. Ten per cent. marketable July 6; 90 per cent. past prime August 2; 10 per cent. with seed stalks August 31.

MORSE.—A cutting variety of a spreading habit of growth; natural spread, 12 inches; market weight, 10 ounces. Leaf 8½ inches long, 7½ inches wide, roundish, thin, stiff, crumpled, blistered, yellowish green; veins large; margins serrate; border frilled. Tender, sweet and crisp. Practically the same as the last. Ten per cent. marketable July 6; 90 per cent. past prime August 12; 10 per cent. seed stalks August 31; still tender and sweet August 20.

BIG BOSTON.—A cabbaging variety. Leaf 9 inches long, 5½ inches wide, obovate, thin, crumpled, blistered, yellowish green, colored at border; margin entire or somewhat undulate; border smooth. Head oval, soft; leaves open at center; blanches well. Tender, sweet, buttery, crisp. With marketable heads August 12; 10 per cent. with seed stalks August 15.

ICEBERG.—A cabbaging variety. Leaf 9 inches long, 7 inches wide, thick, stiff, crumpled, blistered, light green, tinged at border; margin serrate and filled. Head well defined, firm, the leaves well past center; blanches well. Tender, sweet, buttery and crisp. Ten per cent. marketable August 5.

BURPEE'S HARDHEAD.—A cabbaging variety; natural spread, 14 inches. Leaf 7 inches long, 7 inches wide, thin, crumpled, dark green, colored bright red; margin entire; border smooth. Head well defined, globular, the leaves open at center. Tender, sweet, buttery. Ten per cent. marketable August 12; 10 per cent. with seed stalks August 31.

VARIETIES OF CABBAGE.

VARIETY	When 10 per cent marketable	Per cent forming market-able heads	Average market weight
Early Winningstadt	......	25	2¼
Early Spring	Aug. 24	25	3
Burpee's Allhead Early	Sept. 15	15	3
New Extra Early Express	Aug. 12	75	2½
Burpee's New Early Baseball	Sept. 15	25	3
Burpee's New Early Stonehead	Aug. 4	25	5½
Burpee's Danish Roundhead	Sept. 15	15	3
Savoy No. 1625	Aug. 24	25	4

NOTES ON THE VARIETIES.

EARLY WINNINGSTADT.—Plant comparatively large, of upright habit of growth; leaves many. Outer leaves with distinct petiole, broad, flat, with much bloom, bluish green; surface smooth; border waved. Head pointed; section angular; leaves well past center. Inner leaves well blanched, brittle, tender, sweet, mild flavored.

EARLY SPRING.—Plant of compact growth and with many leaves. Outer leaves broad, flat, clasping, bright green; veins large; surface smooth; border waved. Head flat, leaves well past center. Inner leaves loose at base, brittle, tender, sweet, mild flavored.

BURPEE'S ALL-HEAD EARLY.—Plant large, of upright habit of growth. Outer leaves large and long, bluish green, with much bloom and with distinct petioles; surface smooth; margin undulate. Head flat; leaves tightly drawn and well past center. Inner leaves brittle, tender, sweet and mild flavored. Core large.

NEW EXTRA EARLY EXPRESS.—Plant of compact habit of growth. Outer leaves round, broad, clasping, bright green; surface smooth; border waved. Head oval, somewhat pointed; section angular; leaves well past center. Inner leaves loose at base, somewhat brittle, fairly tender, sweet, mild flavored. A desirable variety, very much like Jersey Wakefield.

BURPEE'S NEW "EARLY BASEBALL".—Plant of compact habit of growth. Outer leaves round, broad, flat, somewhat clasping, bright green; surface smooth; border waved. Head globular; section round; leaves tightly drawn and well past center. Inner leaves well blanched, thick, very brittle, tender, sweet.

BURPEE'S NEW EARLY STONEHEAD.—Plant large, spreading habit of growth. Outer leaves large, long, bluish green, with much bloom and with distinct petioles; surface smooth; margins entire, somewhat undulate. Head globular; section round; leaves tightly drawn, well past center. Inner leaves well blanched, thick, very brittle, tender, sweet.

BURPEE'S DANISH ROUNDHEAD.—Plant large, upright habit of growth. Outer leaves large and broad, bluish green, with much bloom; veins large; surface smooth; border waved. Head nearly globular; leaves tightly drawn; leaves well past center. Inner leaves loose at base, well blanched, brittle, tender, sweet, mild flavored. Core large and long.

SAVOY NO. 1625.—Plant of compact habit of growth. Outer leaves broad, clasping, yellowish green; surface crumpled and coarsely savoyed; margin undulate. Head flat; leaves open at center.

RELATIVE WEIGHTS OF HULL AND KERNEL OF OATS.

It is well known that oats grown at Laramie and other localities in Wyoming are heavier than those grown at the much lower altitudes of Nebraska. Desiring to know whether there is any marked difference in the relative weight of hulls and kernels between Wyoming and Nebraska oats, the Director requested me to secure some data on this point. Samples were accordingly procured and ten representative grains of each lot weighed, the hulls then removed and the weight of the kernels taken. Four samples of Nebraska oats, three white and one black, were secured at stores in Laramie. Eight samples of oats grown on the Experiment Farm at Laramie and one from Sheridan were compared with these. A sample of oats of the Clydesdale type grown in Idaho was also found at one of the stores. The results of the investigation are tabulated below:

No.	DESCRIPTION OF SAMPLE	Weight of ten seeds, milli-grams	Weight of ker-nels, milli-grams	Weight of hulls, milli-grams	Per cent kernels	Per cent hulls
1.	Lincoln Oats, grown at Laramie	295	208	87	70.5	29.4
2.	American Banner Oats, grown at Laramie	365	257	108	70.4	29.5
3.	Race Horse Oats, grown at Laramie	392	268	124	68.3	31.6
4.	White Russian Oats, grown at Laramie	340	242	98	71.1	28.8
5.	White Oats, grown in Nebraska	277	192	85	69.3	30.6
6.	White Oats, grown in Nebraska	267	188	79	70.4	29.5
7.	White Oats, grown in Nebraska	282	193	89	68.4	31.5
8.	Surprise Oats, grown at Sheridan, Wyo.	393	252	141	64.1	35.8
9.	Clydesdale Oats, grown at Laramie	377	239	139	63.2	36.7
10.	New Zealand Oats, grown at Laramie	397	256	141	64.4	35.5
11.	Barley Oats, grown in Idaho	408	268	140	65.6	34.3
12.	Cape Oats, grown at Laramie	406	277	129	68.2	31.7
13.	Black Beauty Oats, grown at Laramie	337	223	114	66.1	33.8
14.	Black Champion Oats, grown at Laramie	314	220	94	70	29.9
15.	Black Tartarian Oats, grown at Laramie	332	220	112	66.2	33.7
16.	Black Oats, grown in Nebraska	292	215	77	73.6	26.3
	Average of four samples of white oats grown at Laramie (Nos. 1-4)	348	243	104	70	29.8
	Average of three samples of white oats grown in Nebraska (Nos. 5-7)	275	191	84	69.3	30.5
	Average of three samples of black oats grown at Laramie (Nos. 13-15)	327.6	221	106	67.4	32.4
	Average of three samples of barley oats grown in Wyoming (Nos. 8-10)	389	249	140	63.9	36

The weights given in the table show that there is little difference in the percentage of hull between the common white oats of Wyoming and those of Nebraska. The data obtained bring out other points worthy of notice. Comparing the white oats from Wyoming with similar grain from Nebraska, we find that the average weight of ten kernels of the former is 348 milligrams and that of the latter 275, confirming the assertion of merchants that Wyoming oats are heavier than those of Nebraska. An interesting point in regard to barley oats may also be noted. It is a matter of common observation that this kind of oats are heavier than the common varieties of the Lincoln type. It would be natural to suppose that this difference was due to a lighter hull. On the contrary, we find that the hull of the barley oat, being thick and firm, weighs more than those of common white kinds. Oats of the Lincoln type would, therefore, furnish a larger amount of kernels and hence of nutriment per hundred pounds than barley oats, though the latter would be the more profitable to raise, the yield in bushels being equal.

The common Nebraska oat sold in our market is raised without irrigation, and, because of its light weight, is sold at a less price than is commanded by the Idaho, Colorado or Wyoming oat raised under irrigation.

WHEAT VARIETIES.

For a number of years the Experiment Station has grown several hundred varieties of wheat. In order to test on a larger scale, the best varieties adapted to Wyoming conditions, and that we might have a supply of seed for distribution among farmers in the state, twenty-two varieties have been selected and planted this spring. The varieties selected are wheats of desirable type for cultivation, which in our experience have produced heavy grain, and matured reasonably early at Laramie. They are mostly flouring wheats of thrifty growth and large, well-filled heads. The seed produced in 1903 was used, and about six rows two hundred feet long was planted of each kind. A list of the varieties is given below:

No. 4—White Russian.
No. 25—China Tea.
No. 34b—Pringles No. 4 (?).
No. 54—Velvet Chaff.
No. 57—Amethyst.
No. 84b—Moscow (?).
No. 86—Scotch Fife.
No. 145—Red Oregon Club.
No. 153—Nox No. 2.
No. 154—Nox No. 1.
No. 156—Nox No. 3.
No. 192—Geiger.
No. 222—Saskatchewan.
No. 302—Flourspar.
No. 331—Week's.
No. 343—Sheriff.
No. 360—Missogen.
No. 413—Little Wonder.
No. 428—Leak's.
No. 460—Cordova.
No. 465—Borneo.
No. 469—Noah.

GRASS AND FORAGE PLANT INVESTIGATIONS IN CO-OPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE.

The co-operative work begun in 1901 was continued until in June, 1903. Since that time the work along this line has consisted of observations on the grass plats, of which there are about forty. During the past season the grasses made a growth very similar to that of 1902. They were nearly all later in

coming into bloom, but reached maturity as early or earlier than in 1902. From the seed sown in 1903 a more or less complete stand was obtained of ten grasses.

This spring there has been an unusual amount of rainfall, and the grasses have as a result made considerable growth. The grasses and other forage plants sown in the fall of 1902, as stated in the last report, all came up in the following spring. The young seedlings were plainly discernible in June, but later in the season some of the sorts sown could not be detected. The things sown were *Agropyron occidentale, A. spicatum, Bromus inermis, Poterium sanguisorba, Eurotia lanata, Atriplex argentea, A. Nuttallii,* and *A. truncata.* Of these only the Brome-Grass and *Eurotia lanata* could be distinguished this spring. Very few plants of the Brome-Grass were seen, but those of *Eurotia* were quite numerous. There can be no doubt but that the two species of *Agropyron* have persisted, though one cannot distinguish them from other grasses when so young and at this time of the year.

The most important consideration in the cultivation of grasses in Wyoming is a sufficiency of moisture to ensure a good germination of the seed. Most seasons are too dry and the grasses do not come up. Success or failure in the making of grass meadows depends upon the abundance or scarcity of moisture during the first year. We must depend upon late snows and the early spring rains to bring them up. To secure full benefit from early spring rains one should sow the seed in the fall or very early in the spring. We have found that a stand of most grasses may be secured on cultivated land when the conditions are favorable, and often there is sufficient moisture in spring. Our experiments have shown that when there is less than one inch of precipitation during each of the months of April, May or June, the grasses do not become established. If, however, the precipitation for these three months aggregates three or four inches, good results may be expected. Since the seasons vary so much, failures will occur, and only

when moisture is fairly abundant in spring will good stands be secured.

We have found that many native grasses are as easy to start as most cultivated sorts. Our native Wheat-Grass and Brome-Grasses have produced good stands on the Experiment Farm when, with identical treatment, red top and timothy have failed to come up. Grasses with small seeds appear to be difficult to start, and their growth during the first season is so small that the minute plants may be entirely overlooked. Those with large seeds, such as the Wheat-Grasses, readily make a stand and put out a considerable amount of leafy growth the first year.

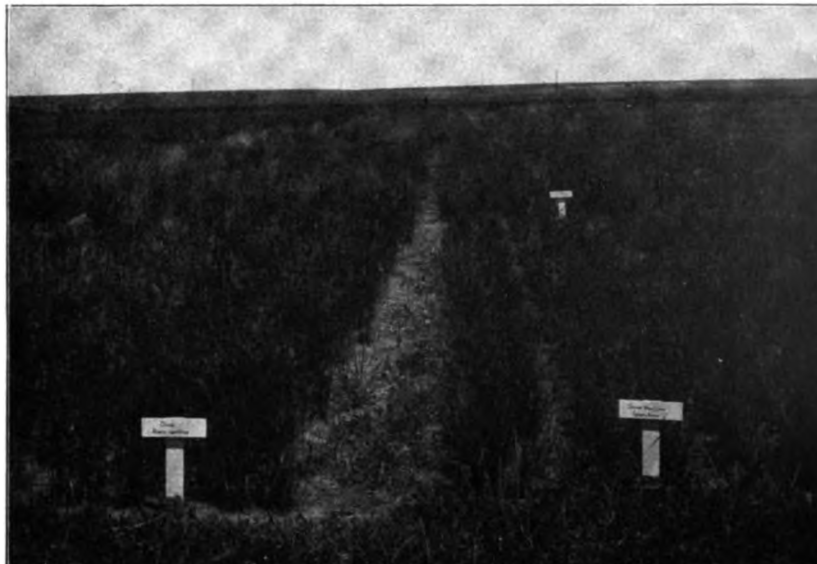
As a rule, the first year's growth of grasses with us is insignificant and no heads appear until the second season. It thus required two years for the common perennial grasses, both native and cultivated, to reach maturity, even on cultivated land.

On the range, with or without cultural treatment, it is more difficult to establish the grasses, and, though they may germinate well when the moisture is abundant, they are not always able to persist when dry weather follows. The growth on the range also is slower and smaller in amount.

We have observed that the grasses on the plats are much thriftier, grow taller and head better where the stand is thin and about the edges of the plats than where the stand is thick or in the center of the plats. It seems true of all the grasses with us that where the sod has thickened up they make little growth and do not head well.

NOTES ON GRASSES TESTED AT THE EXPERIMENT FARM AT LARAMIE, 1901-1903.

The grasses tested were all given field treatment; were sown broadcast by hand on well prepared land in good state of cultivation, and the seed covered by means of a smoothing harrow. Seed of most of the grasses tried was received from



GRASS PLATS, EXPERIMENT FARM, LARAMIE.

the U. S. Department of Agriculture, while some was secured from dealers in farm seeds. In many cases no stand was secured, either on account of insufficient moisture for germination or on account of quite evident lack of vitality of the seed. The grasses have been grown under arid conditions with little or no irrigation, which accounts for the small amount of growth which many have made.

Agropyron caninum.—Bearded Wheat-Grass. In 1901 a good stand was secured. In 1902 it made a considerable growth in the spring, the leaves being three to five inches long May 8, and six inches long May 28. The heads did not appear until the second week in July. It was in bloom August 4, and by August 29 the seeds were ripe. The average height attained during the season was fifteen inches. The growth in 1903 was very much the same.

Agropyron occidentale.—Western Wheat-Grass. This grass was sown in 1901, when it made a good stand and grew to the height of six to nine inches. It made a fairly good growth, but no heads appeared. In 1902 it was four to six inches high May 8, and six to eight inches high May 28. The stems which appeared were twelve to fifteen inches high. It was in bloom from August 4 to August 18, while the seeds were not ripe until about September 20. In 1903, as in the preceding season, it did not head generally over the plat. It attained a height of eighteen inches and was in bloom about two weeks earlier than in 1902. The growth which it made on the farm was not large and represents what it will do without irrigation. It seems to do poorly when it has become root-bound. In fertile, well-drained soil and with irrigation it, however, gives large yields, as we have often observed.

Agropyron spicatum.—Bunch Wheat-Grass. A thin stand was secured in 1901, the seedlings appearing after the plat was irrigated, which was on July 15. In 1903 it headed about June 24; was in bloom before the middle of July, and matured early in August.

Agropyron spicatum inerme.—Bunch Wheat-Grass. This awnless variety is more suitable for cultivation than the species itself. It was sown in the spring of 1901. The seed germinated well and a good stand was secured. In 1902 it was three to six inches high May 8, eight to ten inches high May 28, ten to seventeen inches high June 11, and twelve to twenty-five inches high June 24. The heads appeared about June 1, and from about July 1 to July 8 it was in bloom. The seeds were ripe August 21. The average height was twenty inches, and the radical leaves were ten to twelve inches long. During the dry weather of September it cured on the ground. In October it freshened up and made some aftermath as a result of an abundance of moisture and the fine weather which prevailed. In 1903 it made a much larger growth, attaining an average height of twenty-seven inches, and the blooming period was somewhat later. The seed-holding power of this grass was not found to be good.

Agropyron dasystachyum subvillosum.—Bench-land Wheat-Grass. A good stand was secured in 1901. Its growth has been very similar to that of Western Wheat-Grass. In 1902 it was three to five inches high May 8, six to ten inches high May 28, and seven to twelve inches high June 11. It was headed by June 24, in bloom from July 8 to July 18, and mature about August 11. The average height was fifteen inches. In 1903 it attained a height of eighteen inches. Like that of Western Wheat-Grass, the plat has become root-bound and the grass has not headed well.

Agropyron tenerum.—Slender Wheat-Grass. In 1901 a good stand was secured. It grew to be fifteen to twenty-four inches high during the season, and a few isolated heads appeared. During the dry season of 1902 it made a fair amount of early growth in the spring and attained an average height of eighteen inches. During May it made a better showing than *Bromus inermis.* The heads appeared between June 24 and July 8. It was in bloom during the early part of July,

and by the middle of August the seeds were ripe. In 1903 it matured somewhat later and attained an average height of twenty-two inches. Seed was produced in abundance both in 1902 and 1903, but the ripening was rather uneven and the seed soon fell to the ground.

Thirty-five pounds of seed drilled in on one acre in 1902 gave a thin stand. In 1903 it made a good showing, the bunches growing to a large size, headed well and stood three and a half feet high. The acre plat was irrigated but once during the season. It was in head by the middle of July and in bloom from July 22 to about August 1. One-half of the acre was cut for hay August 4, yielding 2,065 pounds of cured hay. The remaining half acre was cut with a binder for seed, of which 180 pounds were saved.

When moisture is lacking, and especially when the stand is thick, this grass does poorly, but where the individual bunches have plenty of forage area for the roots it makes a considerable growth even in dry weather; with occasional applications of water, it gives large yields of fine hay.

Agrostis alba.—Red Top. Sown in 1901. Failed to make a stand.

Agrostis canina.—Rhode Island Bent-Grass. Sown in 1901. Failed to make a stand.

Alopecurus occidentalis.—Mountain Foxtail. Sown in 1901. No stand was secured.

Andropogon saccharoides.—Sown in 1901. Did not come up.

Arrhenatherum elatius.—Tall Oat-Grass. Sown in 1903. A fairly good stand was secured. In 1904 it began to head about June 11, when twelve to eighteen inches high. It was two to two and one-half feet high and in bloom the last week in June.

Beckmannia erucaeformis.—Slough-Grass. Sown in 1901. Did not come up.

Bouteloua curtipendula.—Side Oat-Grass. Sown in 1901. Did not come up.

Bouteloua oligostachya.—Blue Grama-Grass. Sown in 1901. A very few seedlings appeared, and these made little growth that season. In 1902 the leaves were one to three inches long June 24, and two to six inches long August 11. It did not produce any heads. The plat was plowed up in the spring of 1903.

Bouteloua Rothrockii.—Rothrock's Grama-Grass. Sown in 1903. Did not come up.

Bromus inermis.—Smooth Brome-Grass. Sown in 1901, when a good stand was secured. In 1902 it had a leafy radical growth three to five inches high May 8, and six to ten inches high August 11. The heads appeared about June 11, it was in bloom from about July 8 to August 4, matured from the 11th to the latter part of August, and attained an average height of fifteen inches. The seed-holding power was very good, but the ripening of the seed very uneven. The growth in 1903 was very similar.

This grass has not made a satisfactory growth on the farm. It quickly becomes root-bound and then makes only an inferior growth. About the edges of the plat it, however, grew quite thriftily, and individual clumps, with plenty of forage area for the roots, make luxuriant growths. In many localities in Wyoming it makes excellent crops of hay.

Bromus marginatus.—Short-awned Brome-Grass. Sown in 1901, when a good stand was obtained. It produced an abundance of radical leaves, eight inches long the first season. In 1902 it attained an average height of eighteen inches, the heads appearing about June 15, was in bloom from about July 1 to July 18, and the seed was mature about August 12. The radical leaves were three to four inches long May 8, and eight to twelve inches long August 11. This is a bunch-grass, with a small amount of short-lived radical leaves. It is not as drought-resisting as *Bromus inermis.* It matured its seeds quite unevenly, and its seed-holding power is not good.

Bromus pumpellianus.—Western Brome-Grass. Sown in 1901 and sparse stand secured. In 1902 it made a very thrifty

WESTERN BROME-GRASS ON EXPERIMENT STATION FARM, LARAMIE.

growth, the radical leaves being especially abundant and luxuriant. The radical leaves were three to five inches long May 8, and nine to sixteen inches long August 11. It attained an average height of twenty-one inches, the heads appearing about June 5; was in bloom from about June 15 to July 8, and the seeds were mature about August 6. Its seed-holding power was good, but the seeds ripened very unevenly. In 1903 it grew two feet high and was in bloom about two weeks later.

This is a promising grass, with the sod-forming habit of *Bromus inermis,* which it surpasses in thriftiness and the amount of radical growth.

Bromus Richardsoni pallidus.—Richardson's Brome-Grass. Sown in 1901, when a very sparse stand was secured. In 1902 it attained a height of fifteen inches, and its leafy radical growth was four to five inches high May 8, and six to twelve inches high August 11. Heads appeared about June 24. It was in bloom from about July 20 to about August 30. This grass has an abundance of radical leaves.

Bromus secalinus.—Chess. Sown in 1903 and a good stand secured. It produced a considerable leafy radical growth, remained green and did well the first season. This spring it was nine to fifteen inches high June 10 and fifteen to twenty inches high June 24, at which time it was headed. It was in bloom the latter part of June.

Bromus unioloides.—Rescue-Grass. A good stand was secured in 1901. It did quite well, grew to an average height of eighteen inches and produced considerable seed. In 1903 a volunteer crop appeared from the seed of the preceding season. The heads appeared after July 8, and by August 4 the blooming period was past. The seed was ripe about August 18. Since this grass is an annual and does not give a very rank growth, it is not of great value for Wyoming.

Calamagrostis Canadensis acuminata.—Canada Blue-Joint. Sown in 1901. Did not come up.

Chaetochloa italica.—Miller or Hungarian Grass. Two plats were sown in 1901. No. 4869 (U. S. Department of Agriculture, seed from China) made a good stand, attaining a height of twelve to twenty inches, but did not head. No 2798 (seed from Russia) grew to be twelve inches, but only a few heads appeared.

Cynodon dactylon.—Bermuda Grass. Sown in 1901. Did not come up.

Cynosurus cristatus.—Crested Dog's-Tail. Sown in 1901. Did not give a stand.

Dactylis glomerata.—Orchard Grass. Sown in 1903, when it made a good stand. It made very little growth the first season. This spring it was seven inches high June 10. It had not headed by the end of June, though a few heads had appeared. A few stray bunches observed on the farm in 1902 were in bloom on June 24.

Dactylactinium Australense.—Sown in 1901. Did not come up.

Eatonia obtusata.—Early Bunch-Grass. Sown in 1901. No stand was produced.

Elymus Canadensis.—Wild Rye or Canada Rye-Grass. A good stand was secured in 1901. It headed and attained a height of eighteen to twenty-seven inches the first season. In 1902 it was three feet high August 11, the heads appearing about August 1, was in bloom from about August 11 to August 18, and the seed was ripe September 8. Its growth in 1903 was quite similar.

Elymus condensatus.—Giant Rye-Grass. Sown in 1902. A very poor stand was secured and the seedlings made very little growth. It did not head in 1903.

Elymus glaucus.—Mountain Rye-Grass. Sown in 1901, when a fairly good stand was secured. In 1902 the radical leaves were three inches long May 8, and eight to ten inches long August 11. It attained an average height of eight inches, the heads appearing from June 24 to July 8; was in bloom from

about July 18 to August 4, and the seeds were ripe before September 1. In 1903 it matured much earlier, the seeds being ripe about August 11. This grass has an abundance of broad radical leaves. The seeds ripen rather unevenly.

Elymus Macounii.—Macoun's Rye-Grass. Sown in 1901. The seed was evidently not good, for it did not give a stand. This is a bunch grass, which is unusually leafy and makes quite a rank growth. We believe it can be grown as readily as other native rye-grasses.

Elymus simplex.—Sown in 1903. Did not make a stand.

Elymus triticoides.—Meadow Rye Grass. Sown in 1902. A very poor stand was produced. It did not head in 1903, but this spring some heads have appeared. These appeared about June 24, the stems at that time being fifteen to thirty inches high.

Elymus Virginicus submuticus.—Virginia Rye-Grass. Sown in 1901, when a good stand was secured. It attained a height of thirteen inches in 1902, and its heads appeared about July 18. It was in bloom from about August 1 to August 11, and the seeds were not ripe until September 8. Its growth in 1903 was quite similar. This awnless form is a late grass with us and does not make a rank growth.

Eragrostis Neo-Mexicana.—New Mexico Crab-Grass. A good stand secured in 1901. It attained a height of fifteen to thirty inches and matured an abundance of seed, which was gathered and sown the following spring. The season of 1902 was very dry, and on that account very few seedlings appeared and these made little growth.

Oryzopsis cuspidata.—Indian Millet. Sown in 1901. It did not give a stand.

Festuca elatior.—Fall Fescue. Sown in 1903, when a thin stand was secured. This spring its heads appeared about June 24, when it was eight to fifteen inches high.

Festuca Kingii.—King's Fescue. Sown in 1901. It did not give a stand.

Festuca pratensis.—Meadow Fescue. Sown in 1901, when a fairly good stand was secured. The leaves were six inches long September 7. In 1902 the radical leaves were two to three inches long May 8, and six to eight inches long August 11. It attained a height of twenty inches, the heads appearing about June 11; was in bloom from about June 24 to August 4, and the seed matured after August 11. The seed ripened rather unevenly. Its growth in 1903 was quite similar, but the blooming period was later.

Festuca rubra.—Red Fescue. A fairly good stand was secured in 1901. The plants were very small the first season. In the spring of 1902 it made an early growth, the leaves being two to three inches long May 8, and six inches long May 28. It attained an average height of twenty inches, the heads appearing about June 11. It was in bloom from about June 11 to June 24, and the seeds were ripe about August 4. The growth in 1903 was quite similar. With us Red Fescue has made a considerable growth, is early and does tolerably well under arid conditions.

Festuca scabrella.—Great Bunch-Fescue. Sown in 1901, but no stand produced. A valuable native grass in this region, worthy of further trial.

Hilaria mutica.—Black Mesquite. Sown in 1901. Did not make a stand.

Leptochloa dubia.—Sprangle Top. Sown in 1901. No stand was secured.

Lolium Italicum.—Italian Rye-Grass. Sown in 1902, but as the season was very dry, no stand was produced.

Lolium perenne.—Perennial Rye-Grass. Sown in 1902, when a very good stand was secured. It made a luxuriant, leafy growth that season, but was winter-killed the following winter. On another plat, where it was sown with alfalfa, some of it lived through the winter, but has since then run out.

Muhlenbergia racemosa.—Wild Timothy. Sown in 1901, but no stand secured.

Panicularia Americana.—Manna-Grass. Sown in 1901. It did not give a stand.

Panicum bulbosum.—Red Alkali Saccaton. Planted in 1901. No stand produced.

Panicum Crus-Galli.—Barnyard Grass. A good stand secured in 1901. The plants attained a height of eight to nine inches by September 7.

Panicum Texanum.—Colorado Grass. A sparse stand secured in 1901. The plants were one to four inches high September 7.

Panicum miliaceum.—Broom-corn Millet. Eight plats of Broom-corn Millets were grown in 1901. In height they varied from five to twenty-eight inches and produced an abundance of seed. No. 5057 (U. S. Department of Agriculture, seed from Walla Walla, Washington) was fifteen to twenty-eight inches when mature. No. 5647 (seed from Russia), ten to fifteen inches high. No. 5648 (seed from Russia), twelve to nineteen inches high. No. 2806 (Red Broom Millet from Russia), twelve to twenty inches high. No. 2807 (Yellow Broom-corn Millet from Russia), a few plants ten to eighteen inches high, headed and matured seed. No. 2808 (Black Broom-corn Millet from Russia), fifteen to twenty-eight inches high.

Phalaris arundinacea.—Red Canary-Grass. Sown in 1901. Did not come up.

Phleum pratensis.—Timothy. Sown in 1901, but failed to produce a good stand. Timothy is successfully grown in many localities in Wyoming. It is best adapted to wet meadows, as it requires much water.

Poa glaucifolia.—A blue-grass native of this region. Sown in 1901, but no stand produced.

Poa laevigata.—Smooth Blue-Grass. In 1901 we failed to secure a stand of this blue-grass. It was sown again in 1903, when a good stand was secured, though it made but an insignificant growth that season. This spring it was six to

nine inches high June 10, when the heads began to appear. On June 24 it was twelve to eighteen inches high and coming into bloom.

Poa macrantha.—Seaside Blue-Grass. Sown in 1901. A few seedlings appeared, but a stand was not secured.

Poa Nevadensis.—Nevada Blue-Grass. Sown in 1901, but no stand secured.

Poa pratensis.—Kentucky Blue-Grass. Sown in 1901. Though a few plants appeared, a stand was not produced.

Poa sudetica.—(Seed from France.) Sown in 1901. No stand was secured.

Puccinellia airoides.—Alkali Meadow-Grass. Sown in 1901, but no stand secured. In 1903 it was again sown, when it gave a thin stand. It made very little growth that season. This spring it was eight to twelve inches high June 10, and on June 24, when the heads were beginning to appear, it was twelve to eighteen inches high. This is a valuable grass for wet alkali meadows and makes fine hay.

Sporobolus airoides.—Alkali Fine-top. Sown in 1901. No stand secured.

Sporobolus cryptandrus.—Dropseed. Sown in 1901. Did not give a stand.

Sporobolus brevifolius.—Steel-Grass. Sown under field condition in 1901. It gave no stand. On a plat which was sprinkled frequently with water it made a very good stand, grew quite well and headed the first season.

Sporobolus Wrightii.—Saccaton. Sown in 1901. Did not come up.

Stipa viridula.—Green Needle-Grass. A good stand was secured in 1901. The leaves were four to six inches high by September 7. In 1902 the leaves were two to three inches long May 8, and seven to ten inches long August 11. It attained an average height of fifteen inches, the heads appearing about June 24, was in bloom from about July 1 to July 15, and the seeds were ripe about August 15. In 1903 the growth

was quite similar, but it was twenty-eight inches high and the seeds were ripe about August 1. Its seed-holding power is not good and the seeds ripen very unevenly.

FORAGE PLANTS OTHER THAN GRASSES.

Cicer arietinum.—Chick Pea. Planted by hand in 1901. It came up well, but was nearly destroyed by hail on July 15, and kept down by rabbits and gophers the rest of the season. In 1903 it was again grown. It did well, the plants being quite bushy, with stems nearly two feet long. Produced some seed.

Erodium cicutarium.—Alfilaria. A good stand was secured in 1901. It ripened seed and individual plants were from six to twenty-four inches across.

Eurotia lanata.—Winter Fat. Planted in 1902. Though the season was unusually dry, it gave a thin stand. By July 8 the plants were two inches high, and on August 4 two to eight inches high. Some plants flowered the first season. In 1903 it started to grow early and began to flower about July 1. It attained a height of from eight to eighteen inches and matured seed after the first of August. In the fall of 1902 it was sown on disced pasture land and the seeds covered by means of a smoothing harrow. It came up well the following spring, and, though it has made very little growth, it still persists on this plat.

Glycine hispida.—Soy Bean. Planted in 1901. It came up well, but was injured by frost June 6, and nearly destroyed by hail in July. This southern forage plant is quite evidently unsuited to our climate.

Hedysarum Americanum.—A valuable native forage plant, similar to Sulla. Sown in 1902, but did not come up.

Lathyrus sativus.—Bitter Vetch. Planted by hand in 1901 and a good stand secured. Though nearly destroyed by hail in July, it recovered and stood five to eighteen inches high September 11. It was then still flowering and had some pods which were nearly mature.

Medicago denticulata.—Burr Clover. It made a good stand in 1901, and the individual plants were from eight to twenty-five inches across.

Melilotus officinalis.—Yellow Sweet Clover. A very good stand secured in 1901. It began growth early in 1902, and was in bloom from about June 24 to August 27. It made a dense growth about eight inches high and completely covered the ground. It was killed by frost on September 11. Some plants appeared in 1903 from seed produced in 1902.

Onobrychis sativa.—Sanfoin or Esparcette. A plat was sown in 1901 and a fairly good stand secured. This plat was plowed up the following spring. Esparcette does quite well with us and is quite drought-resisting. It persisted on the farm along drives and other dry situations for many years.

Pisum arvense.—Field Pease. Sown in 1901, but destroyed by hail. Varieties of this forage plant have been successfully grown on the farm, and on good land field pease is a paying crop.

Poterium sanguisorba, Burnett.—A fairly good stand was secured in 1901. It made only a leafy radical growth the first season. In 1902 it was two to four inches high May 28; continued to flower from about June 11 till in September, and matured considerable seed. It attained an average height of eighteen inches. It was not at all injured by the severe frost of September 11 and remained green until in October. Its growth in 1903 was very similar.

Trifolium hybridum.—Alsike Clover. It did not give a stand under field conditions in 1901 or 1902. Thrifty, bushy plants may be seen on the farm in summer.

Trifolium pratense.—Red Clover. Sown in 1901, but no stand secured. It persists as a weed in many places on the farm, growing to a height of about a foot and a half.

Trifolium repens.—White Clover. Failed to give a stand in 1901. It persists from year to year in moist places on the farm, and in the city it is quite common in lawns.

Typical Salt-Bush Land Near Point of Rocks, in the Red Desert of Wyoming.

Vigna Sinensis.—Cow Pea. A stand was secured in 1901, but the plants were killed by frost June 11. Unsuited to our climatic conditions.

EXPERIMENTS WITH SALTBUSHES.*

For three seasons this Station has prosecuted investigations relative to the cultivation of saltbushes. Most of the results are negative, and it seems that their cultivation in Wyoming will scarcely be profitable. The Australian species are unsuited to Wyoming, as they are too liable to injury from frost, and they do not make a sufficiently rank growth during our short growing season to be of value. Our native perennials are difficult to start, at best of slow growth, and, unless planted on land which is in good tilth, they make a very insignificant amount of growth. Only when there is an abundance of moisture is a good stand obtained. The native annuals, such as *Atriplex argentea, A. philontira* and *A. truncata,* have been found easy of cultivation, grow quite rank and yield a large amount of forage on moist alkali land. Good results have been secured, both from late fall and spring seeding. The best germination has been secured from seed covered half an inch deep, but almost as good results may be had when the seed is left on the surface of the soil. A moist soil is necessary for good results, and a certain amount of weathering, to soften the hard husks, favors germination. They should, therefore, be planted in late fall or very early in spring.

The cultivation of saltbushes in Wyoming is not to be thought of on land where other crops may be grown. Our native annuals can no doubt be grown profitably on moist alkali land and used as pasturage for sheep.

Questions relative to the cultivation of saltbushes in Wyoming have practically been solved at this Station. It now remains to determine their feeding value.

*For detailed report on various experiments see Thirteenth Annual Report.

A more or less complete stand was secured of the saltbushes planted in the spring of 1903, and the observations on their growth are incorporated in the following notes on the species which we have tested:

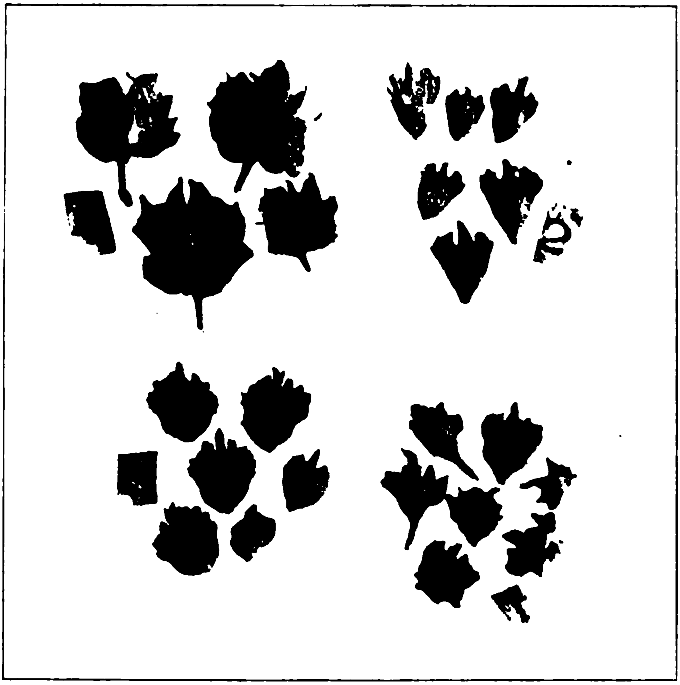
Atriplex aptera.—Dwarf Shadscale. Sown in 1902 and a very thin stand secured. The seedlings were discernible July 8. By August 12 the stems were a foot or more long. Some of the plants flowered.

Atriplex argentea.—Silvery Saltbush. Sown in 1901. Only a few plants appeared, which grew to be of good size and matured seed. These were one to two feet across and eight to fifteen inches high. In 1902 it was again sown, but as the season was very dry, only very few seedlings appeared until in August, when there was some rain, as a result of which enough seeds sprouted to make a fairly good stand. Some of the plants were a foot high and quite broad by September 11, when they were more or less completely killed by a severe frost. In 1903 a fairly good stand was secured.

Atriplex canescens.—Shadscale. In 1901 this saltbush did not come up. In 1902 it was again sown and a few plants appeared. These put out stems from a few to twenty inches long. It was not injured by the severe freeze of September 11. Some seed was planted in 1903 and a thin stand secured. The stems attained the length of about a foot.

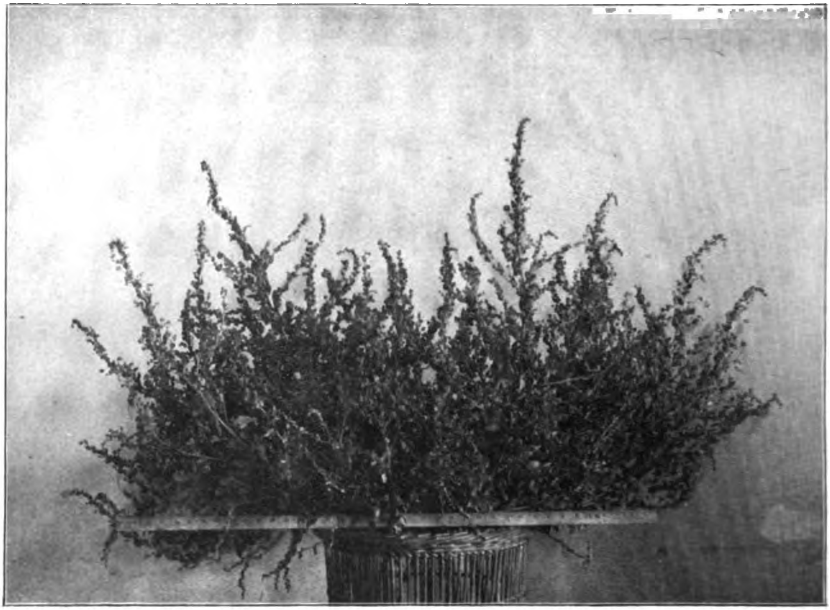
Atriplex confertifolia.—Spiny Saltbush. For three successive years we have planted this saltbush, but it has in each case failed to come up.

Atriplex halimoides.—Mealy or Gray Saltbush. In 1901 quite a number of plants appeared on the plat. These matured seed and were about eight inches high. In 1902 it was again sown, but no seedlings appeared until after the plat was irrigated, which was on July 15 and 16. The plants were only one to three inches high by September 11, when killed by frost. Some seed was planted late in the fall of the same year. A few plants appeared the following spring, but these were only a few inches high in September.

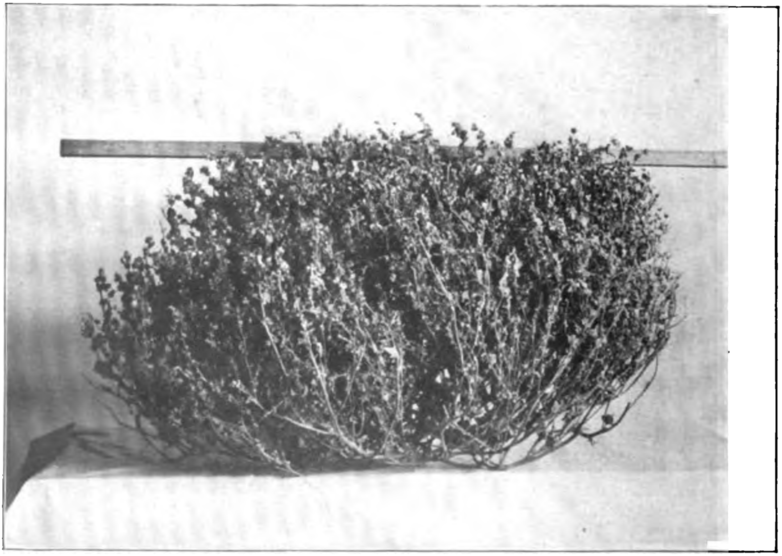


Seeds of Perennial Salt-Bushes.
1. Nuttall's. 2 and 3. Nelson's. 4. Shadscale.

Nuttall's Salt-Bush Spreading on Hard, Gravelly Ground in a Dooryard.
The large plant to the left is the parent of the smaller plants about it.



Utah Salt-Bush (*Atriplex truncata*).



Silvery or Tumbling Salt-Bush (*Atriplex argentea*).

Atriplex holocarpa.—Annual Saltbush. A very thin stand was secured in 1901. The plants were from four to twelve inches high and some were as much as twenty-one inches across. An abundance of seed was produced. In 1902 it was also planted. Only a few plants appeared, and these were killed by frost September 11.

Atriplex lentiformis.—A good stand was secured in 1903, but the plants did not make much growth, being only a few inches to a foot high in September, when they were frost-bitten. No seed was produced.

Atriplex leptocarpa.—Slender Saltbush. No stand was secured in 1902. The following year it gave a fairly good stand. The plants attained a good size, making a dense growth, with prostrate stems a foot long. Considerable seed was produced.

Atriplex linearis.—Sown in 1903, but no stand secured.

Atriplex Nuttallii.—Nuttall's Saltbush. In 1901 this saltbush did not give a stand under field conditions. In 1902 a very thin stand was secured. The plants put out stems a few inches to a foot long and some produced seed. Late in the fall of 1902 it was again planted, a part being raked in by hand and another part left on the surface of the ground. It came up well on both of the plats the following spring and made a good stand. It was also sown on disced pasture land and the seed covered by means of a smoothing harrow in the same fall. Though it came up well in the spring, the plants did not live through the dry summer months. In our experience, a tolerably good stand may be secured of this saltbush on cultivated land when there is sufficient moisture in early spring to ensure a good germination of the seed.

Atriplex pabularis.—Forage Saltbush. This species is very similar to Nuttall's Saltbush, and its behavior under cultivation would be quite comparable to it. It was planted in 1901, and, though it did not give a stand, a few plants were observed on the plat. In 1903 it produced a thin stand, the

plants producing some seed and putting out stems a few inches to a foot long.

Atriplex philonitra.—Spreading Saltbush. Planted in 1902, when it made a good stand and covered the plat with a dense growth a few inches to a foot high. It had not fully matured seed when killed by frost on September 11.

Atriplex polycarpa.—A fairly good stand secured in 1903. The plants were a few to ten inches high. It was more or less frost-bitten in September.

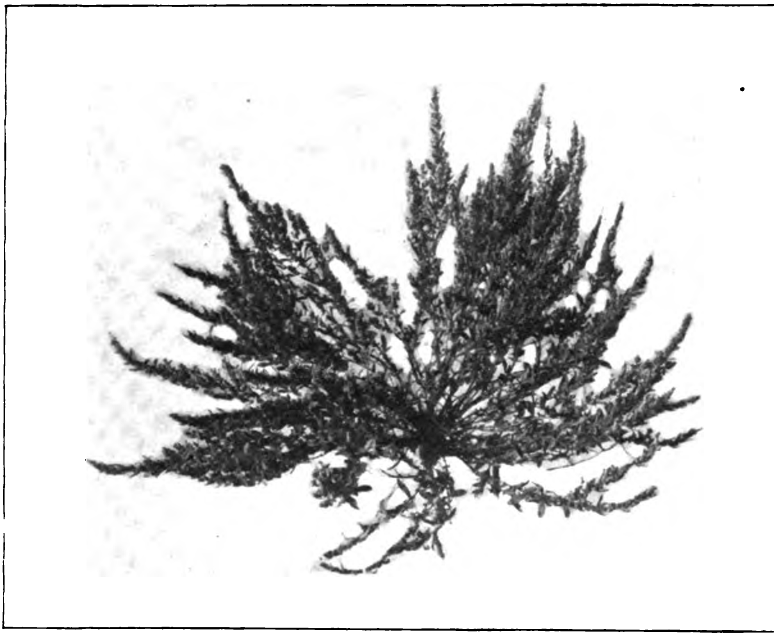
Atriplex polypetala.—Planted in 1903. The stand and growth like the last.

Atriplex semmibaccata.—Australian Saltbush. A fairly good stand secured in 1901. The plants put out stems about a foot long and began to flower about September 11. It did not live through the winter. In 1902 quite a few plants appeared from seed which had evidently laid over since the previous season. These plants spread out twelve to eighteen inches from the crown, and some of them produced a little seed.

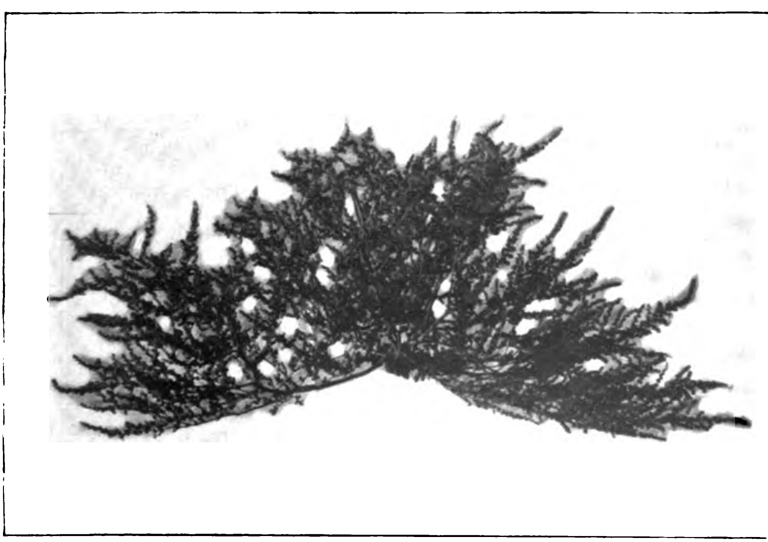
Atriplex truncata.—Utah Saltbush. In 1901 a thin stand was secured, the plants attaining a height of a foot and a half and produced seed abundantly. In 1902 it was again planted. As there was a lack of moisture, it did not come up until after the rain in August. The stand was very good, and the plants about a foot high when injured in the tops by frost on September 11. Some seed was produced and many plants were green as late as October 23. In 1903 it gave a good stand, the plants attaining a height of eighteen inches. In the fall of 1902 it was sown on the range in the same manner as Nuttall's Saltbush. Though it came up unusually well, the following spring it made a very insignificant growth.

FIELD PEASE IN 1903.

Twenty acres of new land broken in the spring were sown with field pease for sheep pasture. Four varieties were grown on this tract of land. The pease made a good stand, but did



NUTALL'S SALT-BUSH (*Atriplex Nuttallii*).



SPREADING SALT-BUSH (*Atriplex philonitra*).

not make a very rank growth, as facilities for irrigation were lacking. The varieties differed in thriftiness and time of maturity, as recorded in the following notes:

MEXICAN FIELD PEASE.—Attained a height of two feet and matured the latter part of August.

WHITE CANADIAN FIELD PEASE.—On August 31 it was two feet high, quite green and still flowering. Did not mature until in September.

GOLDEN VINE FIELD PEASE.—This variety stood fifteen inches high. It matured earlier than the Mexican Field Pease.

GREEN CANADIAN FIELD PEASE.—Attained a height of about eighteen inches. It was all green and still flowering the 31st of August, and did not mature until in September. This variety was also sown on a plat which was in a good state of tilth and had been under cultivation for a number of years. Here it made an excellent growth, the vines in places being six feet long. It was in full flower about August 19, and remained green until in September.

Report of Assistant in Agriculture.

The work assigned to the Assistant is the looking after and making notes and observations of the various crops growing on the Experiment Farm and having in charge the details of the farm management. Records are being kept of the feeding and breeding of the different classes of live stock, viz: horses, beef cattle, hogs, and poultry, now on the farm.

The present Assistant took up his duties in connection with this position early in April, having resigned a similar position in the New Mexico College of Agriculture and Mechanic Arts, which he had held for two years.

HENRY C. MCLALLEN,
Assistant in Agriculture.

THE UNIVERSITY OF WYOMING

AGRICULTURAL COLLEGE DEPARTMENT

FIFTEENTH ANNUAL REPORT

. . . OF THE . . .

U. S. Agricultural Experiment Station

. . . OF . . .

WYOMING

1904-1905

LARAMIE, WYOMING,
U. S. A.

WYOMING

Agricultural Experiment Station.

UNIVERSITY OF WYOMING.

STATION STAFF.

F. M. Tisdel, Ph. D........................President
B. C. Buffum, M. S.........Director, Agriculturist and Horticulturist
A. Nelson, M. S., Ph. D........................Botanist
H. G. Knight, A. M........................Chemist
C. B. Ridgaway, A. M........................Physicist and Meteorologist
G. R. Hebard, A. M., Ph. D........................Secretary
*B. P. Fleming, B. S........................Irrigation Engineer
*E. E. Nelson, A. M........Assistant in Horticulture and Agrostology
*H. C. McLallen, M. S. A........................Assistant Agriculturist
G. E. Morton, M. L., B. S........................Animal Husbandman
F. E. Hepner, B. S........................Research Chemist
E. L. Case........................Stenographer

*Resigned.

Letter of Transmittal.

U. S. Agricultural Experiment Station,
University of Wyoming.

To His Excellency, Bryant B. Brooks, Governor of Wyoming.

Sir:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating Agricultural Experiment Stations, I have the honor herewith to submit the Fifteenth Annual Report of the U. S. Agricultural Experiment Station of Wyoming, for the fiscal year ending June 30, 1905.

B. C. Buffum
Director.

University of Wyoming, June 30, 1905.

Table of Contents.

Report of the Station Staff.

Report of the Director.

ORIGIN AND PURPOSE OF THE STATION.—The Wyoming Experiment Station has received the benefit of the Hatch appropriation for fifteen years, and there has been published fourteen annual reports preceding the present one. These several reports contain a general account of the station and the work of each year. They have not been so widely distributed as the station bulletins and the following paragraph of history and purpose is repeated:

Briefly, the purpose of the station is *research* in agriculture, and the publishing of such bulletins and reports as will enable our people to put to practical use the results of this research. The fact that this expenditure and work is primarily for the benefit of the people of Wyoming does not seem to be so generally understood as it should be. Many do not realize the purport of the fact that the most progressive nations are generously fostering both the theoretical and practical education of those engaged in every agricultural industry. In our own country the two Morrill acts establishing and supporting our Agricultural and Mechanical Colleges provide for the foundation education of our youth, and the Hatch act of 1887 makes an appropriation by Congress of $15,000 annually to each state and territory for scientific research in agriculture and the disseminaton of the results of such investigations to the people through agricultural bulletins, which are sent free upon request for them. Some experimental work was done in Wyoming as early as 1889, and on January 10, 1891, the Leg-

islature authorized the University of Wyoming to receive the appropriation by Congress for the establishment of an Experiment Station. The work of the station was organized and a station staff elected in March and April of 1891. The results of the station work and executive details up to the beginning of the last fiscal year are published in the fourteen annual reports, the sixty-two regular bulletins, and the various press bulletins which have been issued.

THE STATION COUNCIL.—The Experiment Station Council is the executive body which passes on all matters pertaining to the station policy, work, and publications. It is composed of the President of the University, as Chairman; the Secretary of the Board, who is Secretary of the Council; the Director of the Experiment Station, as its executive head; and those professors and assistants in the University and Agricultural College who do research work. The Station Council meets regularly on the second Thursday of each month, and additional meetings are called whenever occasion demands.

The Council recommends plans for work in the several departments of the station and all bulletin material for publication, to the Agricultural Executive Committee of the University Board of Trustees for their adoption. The bulletins as prepared are read and discussed in open council meetings. This plan of passing on the bulletins has given much satisfaction. It prevents extravagant statements and insures a more complete discussion of the results of an investigation than might be made by the writer alone. The subject matter and composition are freely criticised, and the material prepared may be accepted for publication, or referred back to the writer for revision, postponed, or entirely thrown out. This arrangement brings the station workers very closely together, and provides for co-operation along any line of work in which two or more departments may be able to take part. The writer of a bulletin may select two other members of the station staff to aid him in reading proof.

CHANGES IN THE STATION STAFF.—During the summer Frederick Monroe Tisdel, Ph. D., was elected President of the University to fill the vacancy left by the death of Dr. Charles Willard Lewis, and President Tisdel becomes the new Chairman of the Experiment Station Council.

Mr. Henry C. McLallen, M. S. A., who was appointed Assistant Agriculturist, and began work in April, 1904, resigned early in the present fiscal year and no one was selected to take his place.

Mr. Elias Nelson, A. M., Assistant in Horticulture and Agrostology, resigned in October to go to the Pacific Coast. Mr. Nelson was a member of the station staff for several years, and the bulletins and reports show much good work done by him. No one was appointed to fill the place left vacant.

Mr. B. P. Fleming, B. S., Irrigation Engineer of the station since 1901, was given leave of absence for one year to go to Cornell and take up advanced study in engineering. After entering on his work, Mr. Fleming decided on two years' resident study instead of one and sent in his resignation. Mr. Fleming has done much good work for the station, and since resigning has finished two bulletins, one of which, No. 66, was published in June of this year.

Mr. W. E. Field, head farmer on the station farm since Mr. E. E. Sigman left us, was forced to resign on account of his health, and the work has been left in charge of Mr. Price Farrar.

Mr. Frank E. Hepner, B. S., from the South Dakota College, has been added to the station staff as Research Chemist. Mr. Hepner began work October 1st. It was decided to strengthen the technical research of the station, and Mr. Hepner's time is entirely devoted to the station work.

Mr. G. E. Morton, M. L., B. S., was appointed Assistant in Animal Husbandry and began work with October. This appointment adds a strong man to our force of station workers and is in line with the plan to make live stock investigations an important part of the Wyoming work.

THE LIVE STOCK WORK.—Much was done during the year to strengthen the work with live stock. The general matter of assistance has been rearranged to give better organization to stock investigations, and the plans of farm work have been co-ordinated in order to produce more feed to enable us to carry out feeding and breeding experiments. There are now some eighty-four acres of alfalfa on the upper farm, and plans have been made to lay out the alfalfa on the old penitentiary farm, which we occupy, into paddocks and swine pastures. We were unfortunate with our horse breeding work. We had purchased two coach stallions and four breeding mares with state funds and had hopes that we would get more support for the work. However, we have been unable to arrange or equip for this work as should be done to make it successful. In July we discovered glanders in one of the mares and the State Veterinarian was notified. He tested all the horses on the farm and found three of the brood mares and one of the work horses affected. These were appraised, killed, and deeply buried in a trench with quick lime to hasten decomposition and destroy the germs. The stables and yards were disinfected at considerable expense and parts of harness and other movable articles were burned. There has been no recurrence of the disease, but we were left short on horse equipment and have decided to sell the breeding stock and put more money and work into the breeding and feeding of other stock for which we can equip the station with less money.

CATTLE.—In my last report is given an account of our start with Polled Herefords. In the fall we visited Des Moines and purchased eight additional heifers, which were bred to the original Polled Hereford sport, Giant, owned by Warren Gammon. This gave us two herds, one of Herefords and one of Double Standard Polled Herefords. We had some trouble with abortion in these heifers, but have secured at least one bull calf which promises to be polled.

SHEEP—Feeding experiments with rations of alfalfa, native hay, corn, root crops, flaxseed, and home-grown grains were carried along during the winter, and material obtained which will be published in bulletin form. Mr. Morton has a brief technical account of the results of this work in another part of this report.

We have purchased for the station some ewes, both Rambouillet and Franko-Merinoes, and through an arrangement with the F. S. King Brothers Co., sheepmen near Laramie, we are able to begin some breeding experiments with fine wooled sheep. The stock obtained is good material from A. E. Green and Mr. Wood of Michigan. The King Brothers have some of the best bucks to be obtained, one of the new ones being a prize animal from St. Louis.

We hope to take up also studies of western wool to determine shrinkage, character of staple, and effect of alkali soils, dry climate, etc., on the fibre.

SWINE.—We are continuing work with breeding Tamworths and feeding them on feeds which we can produce in our short seasons at high altitudes. Attention is called to Mr. Morton's report in this volume for account of some results of this work.

POULTRY.—Mr. McLallen carried out a hatching test with the incubator last year, and this season Mr. Morton has continued the work in a small way. It seems that there is difficulty obtaining good results with incubators at our high altitudes and we hope to get data which will throw light on the subject.

CHEMICAL STUDIES.—Attention is called to the report of the Station Chemist on page 48. Much work has been accomplished during the year and the work promises much of importance. So far the investigations have been along the two lines of stock food research, viz.: the chemical composition of our common grasses and fodders and their digestibility. Some

discoveries have been made in regard to differences in both composition and digestibility which are of much interest and practical importance, and the differences seem to be in favor of our high altitude foods. The short season and arid climate seem to produce high nitrogen content and greater digestibility than is exhibited by the same plants grown at lower altitudes or in more humid climates.

ASSOCIATION MEETINGS AND OTHERS.—President F. M. Tisdel represented the Agricultural College and the Director represented the Experiment Station as delegates at the meeting of the American Association of Agricultural Colleges and Experiment Stations held at Des Moines, Iowa, in November. During September the Director served on the Jury of Awards in the Agricultural Department at the Louisiana Purchase Exposition. The Wyoming Station won signal honors at this great fair.

The first exhibit to be judged was that from Wyoming, and as our commissioners had only shown the very best things which could be produced in this state, a high standard of excellence was set for the work of the jury. In studying the cereals we made special effort to weigh the best shown from the different states and countries of the world, in order to compare them with those from Wyoming. It should be stated that it was impossible to judge the same kind of grain from different parts of the world on the same basis. We cannot compare the soft wheats of California with the winter wheats of Kansas or with the hard wheats of the Northwest, and grains raised without irrigation cannot be compared with those raised in the arid region with the artificial application of water.

The heaviest wheat shown at the fair was undoubtedly a sample from the Wyoming Experiment Station, which, under careful test, weighed sixty-six pounds per bushel. A sample of wheat was shown in the exhibit from the Argentine Republic, which, it was claimed, weighed sixty-seven and eight-tenths pounds per bushel before it was shipped to St. Louis,

but applying the same test as that used with our Wyoming wheat, this sample weighed a little less than sixty-five pounds. The exhibitor claimed the wheat had dried out since harvest.

We exhibited a sample of oats from Wyoming which weighed forty-eight pounds per bushel, and the heaviest sample discovered from any other state or country was one from New Zealand, which weighed a little more than forty-six pounds, and one from Idaho, which weighed nearly forty-six pounds per bushel. Wyoming brewing barley was shown which weighed fifty-six pounds, and a sample of Purple Hulless from the Experiment Station weighed sixty-seven pounds, which, so far as I could determine, was the heaviest grain at the fair. Perhaps weight per bushel is not always an indication of the best quality, though it must be approximately so for oats, as the weight can only be produced by full, plump kernels and comparatively small amount of husk. In wheat, it is my observation that the weight per bushel varies more with gluten content than with other factors. It is seldom that a starchy wheat is heavy, though some of the soft wheats from Washington and other states weighed more than the standard. As a rule, the Macaroni wheat is heavier than the common variety.

When we carefully consider the conditions, it is not surprising that the Wyoming grain was not excelled by any at the fair, for our high altitude lands which can be irrigated are naturally suited to the production of first-class grains and grasses. The cereals all belong to the grass family of plants, and, with the exception of rice and Indian corn or maize, which are tropical in their habitat, the grains properly belong to the colder portions of the temperate zone. Wheat has been adapted to a wide range of climatic conditions, but wheat, oats, barley, and rye do not thrive well in warm climates. There were some surprisingly good wheats, however, shown from some of our Southern states, though the other cereals, with the exception of the tropical forms from the South, were very poor, at least were so considered when compared with those which grow in more favorable localities. The jury awarded the station a

grand prize for its display of grains and alfalfa samples raised above 7,000 feet altitude.

In the educational exhibit the Director received a gold medal for the Buffum Water Register, which was designed for accurate measurements of water in our station investigations.

The Director was made a member of the State Commission for the Lewis and Clark Exposition, and visited Portland in June to look after the installation of the agricultural exhibit. Our station furnished much grain and other material for this exhibit.

THE WINTER SHORT COURSE.—This year the course was held from January 30 to February 11. The following report was published in the February number of THE RANCHMAN'S REMINDER:

The Second Short Course was very successful in spite of snow storms at the end of the first week and the continued storm and cold weather thereafter which forced many ranchmen to stay in the country and attend to their sheep and cattle. The course opened with a lecture upon "Beef Breeds and Types" by Mr. G. E. Morton, Animal Husbandman for the Experiment Station, the lecture being preliminary to three days' cattle judging in the ring. Judging of feeder steers was given particular attention, as Wyoming winnings at the recent International Show proved her to be one of the best feeder producing states in the country. In connection with this, practical work was given in estimating the age of cattle by their teeth and aroused much interest among the range cattle breeders.

Governor B. B. Brooks attended the course on January 31, and in the evening talked to the ranchmen upon the cattle industry, forcibly emphasizing the fact that under present conditions, with the security offered by the Wyoming live stock industry of today, money should be available at six per cent interest instead of at the high rates prevailing.

The cattle judging was followed by two days of practical work in judging mutton sheep and feeder lambs under the supervision of Professor C. J. Griffith of Colorado Agricultural College. The lambs upon feed in a ration experiment by the Experiment Station were used for judging, and much interest was aroused by the varying condition of lambs upon different rations. Prominent Fort Collins sheep feeders attending the course consider the condition of the lambs sufficient evidence of the feasibility of lamb feeding upon the Laramie Plains at an altitude of 7,200 feet, the freight upon corn being the same for Laramie as for Fort Collins. In connection with this work Prof. B. C. Buffum lectured upon "Lamb Feeding Experiments" conducted at the station, which indicated that the feeding of lambs upon field pease can be carried out at Laramie as successfully as in the San Luis Valley, which has climate conditions almost identical with those at Laramie. In an evening lecture Mr. E. J. Bell gave facts and figures to prove some advantages of such feeding at home.

One of the most important points brought out during the course was the fact that the breeding animal wanted by the range man differs in some respects from the one wanted by the Mississippi Valley breeder, many points of form being considered secondary in importance to a heavy covering of hair or wool and a strong constitution.

Mr. John Seely of Mt. Pleasant, Utah, conducted the judging of fine wool sheep on Saturday of the first week, and as a practical sheep breeder himself, with a national reputation in the show-ring, commanded the respect of the sheepmen operating extensively upon the Laramie Plains. He emphasized the fact that the money-making sheep was the combination wool and mutton sheep, an animal running to either extreme being unsuited to range conditions.

Mr. Thompson of the freight department of the Union Pacific railroad came from Omaha to attend as the representative of his railway and for the purpose of consulting with

ranchmen as to freight rates upon seed, grain, and farming implements.

During the second week Dr. Glover and Prof. Carlyle of Colorado and "Uncle John" Gosling of Kansas City contributed to the wonderful success of the work. Dr. Glover talked on "Common Diseases of Live Stock" and "Tuberculosis in Cattle," and gave a demonstration of examination of horses for soundness. Prof. Carlyle gave two lectures upon "Market Classes of Horses" and "Breeds of Light and Draft Horses," and conducted the horse judging work. Mr. Gosling discussed the relative merits of the animals destined for the slaughter test, and incidentally remarked that the stuff was much better than he expected to find in Wyoming.

The ranchmen present exhibited keen interest in the lambs which had been fed on various experimental rations and were about to be slaughtered. Nearly all considered the lot of lambs fed upon alfalfa, turnips, and barley the fattest and the best killers, although another lot had been fed upon alfalfa, turnips, and corn, and another upon alfalfa and corn. The lambs in a lot fed alfalfa, turnips, and flaxseed gave the barley-fed lot a close run, one lamb in particular from this lot being considered by many the best lamb in the pens. But when the lambs were dressed and cut up the story was told. The barley-fed lamb dressed 58.2 per cent, the flaxseed lamb 53.5 per cent, and the corn lamb 52.4 per cent. The meat of the flaxseed lamb was of a very dark color, but was juicy and of good flavor when cooked. The flaxseed used in feeding was grown on the Laramie Plains, yielding 16 bushels per acre, and was ground and fed without expressing the oil. In combination with alfalfa and turnips it constitutes a very cheap ration, having the advantage over barley or corn in this respect.

In addition to the lamb carcasses three carcasses of beef and three of pork were cut up under Mr. Gosling's supervision, and a large audience listened attentively to the points

brought out by the veteran demonstrator, thoroughly enjoying the happy admixture of humor and common sense in his talks.

"There are no better to be found in the East," was Uncle John's comment on the lambs, and largely owing to his enthusiasm saddles of lamb were sent to President Roosevelt, Secretary Wilson, Governor Brooks, and Mr. Monroe.

At the closing lecture of the course, Mr. E. J. Bell, on behalf of the ranchmen of Albany County and citizens of Laramie, presented Prof. Buffum with a silver loving cup and purse, and Mr. Morton with a gold seal ring and purse in token of their appreciation of the efforts put forth to make the course of practical benefit.

Some acknowledgments are due to our stockmen and others for helping us make the Short Course a success. It is impossible to adequately thank each one who gave their time and effort without expecting or receiving money compensation, and some of our ranchmen went to trouble and personal expense. Mr. E. J. Bell gave us every assistance. He selected the cattle for the block demonstrations and sent them to town and paid for the entertainment of one of our lecturers while in Laramie, besides giving us a heifer for slaughter with the privilege of using her as we wished and returning the proceeds, if there should be any. He did much to interest others in the work and gave us one of the most practical and valuable lectures on the possibilities of feeding stock at home. Several furnshed stock for the judging and Mr. Stickney gave a lard hog for the slaughter test.

Mr. John W. Ernest, who is feeding hay to a thousand cattle on the Little Laramie, presented the Agricultural Department a cow to be used in the slaughter demonstrations. Last year Mr. Ernest gave a mounted head of a Texas range steer, which is hung in the Director's office.

The spirit with which our people took hold of the work in spite of the bad weather is most gratifying to the University authorities, and we hope and believe taking such advantage of the work of our college and station will bring compensation

to the individual and advance the interests of the state. It is a most encouarging thing for the growth and usefulness of the Experiment Station.

LEGISLATION OF INTEREST TO THE STATION.

The last Legislature passed three laws bearing on the agricultural interests of the state, all of which have more or less relationship on the work of the Experiment Station.

FARMERS' INSTITUTES AND SHORT COURSES.—The Legislature made an appropriation of $2,000 to pay the expenses of Farmers' Institutes to be held in different portions of the state. The expenditure of the fund was placed in the hands of the Board of Trustees of the University, and its management was given over to the Agricultural Department of the Agricultural College and Experiment Station. The first institute under this law was held at Cody, Big Horn County, on March 29, 30, and 31, and the lecturers were Profs. B. C. Buffum, Aven Nelson, and G. E. Morton. Seven sessions were held, which were well attended.

STATE EXPERIMENTAL HORTICULTURAL COMMISSION.—Section 50 of the general appropriation bill passed by the last Legislature reads as follows:

"There is hereby appropriated out of any funds in the state treasury not otherwise appropriated, the sum of $2,000, or so much thereof as may be necessary for the purpose of making experiments in horticulture at the Lander experiment farm, at or near Lander, during the two years ending March 31, 1907.

"Said experiments shall be conducted under the supervision of a commission of three persons to be appointed by the Governor for a term of two years, who shall serve without compensation.

"The funds herein appropriated shall be available to meet the expenses incurred in making said experiments upon vouchers approved by a majority of said commission."

To carry out the provisions of this act, Governor Brooks has appointed Hon. J. M. Hornecker of Lander, Hon. Ed. Young of Dallas, Fremont County, and B. C. Buffum, Director of the Experiment Station, as members of the Experimental Horticultural Commission. This is the first state support of scientific investigation of our agriculture.

With this appropriation the fruit experiments on the old station farm at Lander are to be enlarged and continued. Some extensive planting has been done this spring.

THE STATE BOARD OF HORTICULTURE.—The following account of this law was prepared by Prof. Aven. Nelson: House Bill No. 65, creating a State Board of Horticulture for Wyoming, is a measure enacted at the recent session of the Legislature of this state which is of more than ordinary interest. It is an act the full significance and value of which will not be fully appreciated during the next decade. It is so rare a thing to see legislation which anticipates the necessities of the years yet to come that we may well point to this as at least one instance in which "the stable was locked before the horse was stolen." Horticulture is yet in its infancy in Wyoming, but it is in the infancy of an industry that proper safeguards should be thrown around it in order to guarantee its successful and profitable development. The horticultural plants (in the broad sense) are peculiarly susceptible to the attacks of insect and fungus pests. Wisely enough this measure seeks to exclude rather than destroy, carrying into practice the old saw, "An ounce of prevention is worth a pound of cure." The older states that are expending tens of thousands of dollars every year, merely in the hope of holding in check the diseases to which their fruits are subject, would give a great deal for the privilege of starting in again with a clean field.

Wyoming finds, as other states have found, that no serious trouble to the crop plants is to be anticipated from the indigenous insects and fungi. The indigenous insects and fungi have grown up in connection with and have adapted them-

selves to their indigenous host plants; and only in those instances in which the introduced crop plants are close allies do the native parasites become a real menace.

Nature undisturbed by man is largely in a state of equilibrium, each organism holding the other in check. The crop plants are such as man has rescued from the severe competition that ordinarily prevails in a state of nature. As these have been led out in lines of development which have made them of greater utility, they have, at the same time, been relieved of the necessity of self-protection against such enemies as weeds and parasites. For that reason it is now incumbent on man that he stand guard over them if he would have that increased productiveness to which they have attained.

But the crop plants, like the native plants, are each susceptible to the attacks of certain specific enemies, hence in new localities the introduced crop plants flourish marvelously until their old-time enemies are also introduced. These often find their way in, unnoticed, in connection with the seeds or plants themselves that we wish to propagate. The purpose of the bill now under consideration is to eliminate, so far as possible, just this specific danger. It provides for inspectors who shall stand guard as it were at the ports of entry.

Not many years ago the naming of a State Board of Horticulture in Wyoming would have been looked upon as a huge joke, but the fact that such a bill could pass our legislative body with little opposition speaks very audibly of the change that the state is undergoing or, for that matter, has already undergone. Such a board would scarcely have seemed in harmony with the conditions when the great cattle outfits dominated our broad domain. But now when farms occupy many of the broad plains, gardens flourish in the sheltered nooks and orchards shed their pink and white blossoms upon the green of our beautiful valleys, it seems but natural to throw about this new phase of our development every reasonable precaution.

The bill provides for a board of six members, to consist of four appointed by the Governor, with the State Executive

and the Professor of Botany in the State University as members, ex-officio. It further provides that the state shall be divided into four horticultural districts to correspond in boundaries to the four water districts—the four appointive members of the board to be selected, one from each district. The board is authorized to employ a secretary and to select for each district an "Inspector of Fruit Pests." This inspector may be the member of the board for that district or may be chosen from without the board.

The object of the bill as stated in Section 7 is as follows:

"Sec. 7. For the purpose of preventing the spread of contagious diseases among fruit and fruit trees, and for the prevention, treatment, cure, and extirpation of fruit pests, and diseases of fruit and fruit trees, and for the disinfection of grafts, scions, and orchard debris, empty fruit boxes and packages, and other suspected material or transportable articles dangerous to orchards, fruit and fruit trees, said board may prescribe regulations for the inspection, disinfection, or destruction thereof, which regulation shall be circulated in printed form by the board among fruit growers and fruit dealers of the state, and shall be published at least ten days in two horticultural papers of general circulation in the state, and shall be posted in three or more conspicuous places in each county in the state, one of which shall be at the county court house thereof."

The bill also provides that only such nurseries may do business in the state as shall first obtain a license and shall deposit a bond to guarantee the observance of the requirements of this law. Proper provision is made for the enforcement, under penalty, of the requirements of the law as they relate to all who are in any way connected with the horticultural industry, including the common carriers of both the products and the nursery stock. The bill seems to be very comprehensive and if its provisions are rigidly enforced it ought to secure for Wyoming, for all time, immunity from any serious invasion by the now known orchard or garden pests.

THE PENITENTIARY PROPERTY.—A bill was passed by both houses of the Legislature turning over to the University for the use of the Agricultural College and Experiment Station the old penitentiary grounds and buildings at Laramie. On account of an error in the engrossed bill, the Governor vetoed the measure. On April 6, 1905, the Board of Charities and Reform passed the following resolution, in accordance with which the Experiment Station continues to occupy the buildings and farm with its live stock. The Assistant in Animal Husbandry occupies the old warden's house and the stock herdsman occupies a small building which has been moved out of the old stockade and fitted for his use by building on a small kitchen:

"*Resolved,* That the application of the Board of Trustees of the University of Wyoming, through its Secretary, Grace Raymond Hebard, for the use of the penitentiary grounds and buildings at Laramie, Wyoming, for the carrying on of experiments for the Wyoming Experiment Station and for the use of the Agricultural College in connection with the State University be approved and granted; said University to have the use of said property until March 1, 1907, the State Board of Charities and Reform reserving the right to use the administration portion of the building and southeast wing, and that none of the buildings belonging to the state shall be dismantled.

"It being further stipulated that the property is to be cared for by the University authorities and kept fully insured and in proper condition without cost to this board, and at the expiration of the time specified, to be turned over to the board in as good condition as when received."

THE AGRICULTURAL COLLEGE.—The law or enabling act under which the people of the state voted in 1892 to place the State Agricultural College at Lander was repealed by this Legislature. This leaves the college and station connected with the University, which was designated by the First State Legislature as the proper institution to receive the funds ap-

propriated by the general government under the Morrill and Hatch acts. The location of the college was all that this former act had accomplished, and the Fremont County delegation never have been able to have the school established at Lander by the necessary appropriation of funds. By the will of Phillip Weiser, an estate valued at $40,000 was left to the Agricultural College when it should be established at Lander. A Board of Agriculture had been appointed after the old enabling act had resulted in a vote locating the school, and this board proceeded to purchase a college farm and organize a school with the Weiser money. With such organization they attempted to gain recognition by the last Legislature and secure the government funds. However, the idea that the state was not yet ready to separate its higher educational institutions prevailed with the result that the former act locating the school at Lander was repealed.

PUBLICATIONS.

The regular station publications during the year consist of four bulletins, numbers 63 to 66, inclusive, and the Fourteenth Annual Report. The year was one of considerable activity, also, in the matter of publishing various articles in the agricultural press and THE RANCHMAN'S REMINDER, which was continued through the year as a monthly periodical. The twelve numbers contain 120 pages, and there are some nineteen articles based on station work, which take the place of press bulletins. Through it, also, we publish notices of Experiment Station bulletins, short articles relating to the agriculture of the state, and advertise short courses, farmers' institutes, and courses of instruction. The expenses of this publication are met from moneys other than the Hatch fund and the paper is helpful to the station. A brief outline of the station publications follows:

FOURTEENTH ANNUAL REPORT.—This report is for the fiscal year ending June 30, 1904. It is a publication of 86

pages and was distributed in December. It contains report of the Director, financial statement of the Treasurer, outline plans of work for the present year, meteorological summary, and the several reports of the members of the station staff. There are technical statements of lamb feeding results, the data accumulated on irrigation of potatoes, and an extensive technical report of the plant work of the Assistant in Horticulture and Agrostology.

BULLETIN NO. 63, AUGUST, 1904.—*Native and Introduced Salt-Bushes, Three Seasons' Trial,* written by Elias Nelson, Assistant in Horticulture and Agrostology. This is a 19-page bulletin, containing seven plates. It reports the results of our co-operative work on the salt-bushes in connection with the Division of Agrostology of the U. S. Department of Agriculture and field tests with the Australian and native salt-bushes. There are descriptions of the most promising species and general recommendations in regard to planting and growing this class of forage plants.

BULLETIN NO. 64, FEBRUARY, 1905, *Feeding Experiments With Lambs, 1903-1904,* written by B. C. Buffum, Director and Agriculturist, is a 20-page bulletin. It contains seven illustrations of lambs on feed and of fat lambs, and reports the results of feeding trials to determine the value of Canadian field pease allowed to ripen and pastured in the field, compared with corn and alfalfa feeding in the feed pens. Some of the lambs were fed on compounded rations with turnips and oil meal.

BULLETIN NO. 65, MAY, 1905, *Wyoming Forage Plants and Their Chemical Composition, Studies No. 1,* was written by Prof. Henry G. Knight, Chemist of the station; Mr. Frank E. Hepner, Assistant Research Chemist; and Prof. Aven Nelson, Botanist. This is a bulletin of 52 pages, containing nineteen plates to illustrate the species under study. The

forage plants of the state are arranged in a popular classification; the chemical terms used are explained and each species is described, both scientifically and in popular terms. There are thirty-six analyses reported, including seven of home-grown alfalfa. This is the first of a series of reports on forage crops which have been planned.

BULLETIN NO. 66, JUNE, 1905, *Irrigation Investigations on the North Platte River in 1904*, written by Mr. B. P. Fleming, Irrigation Engineer, is a 24-page report of field studies of the duty of water and kindred data on lands to be covered by the Pathfinder irrigation project. The bulletin contains one map and three charts illustrating the text.

Financial Statement of the Treasurer.

UNIVERSITY OF WYOMING.

AGRICULTURAL EXPERIMENT STATION

IN ACCOUNT WITH

THE UNITED STATES APPROPRIATION, 1904-1905.

DR.

To receipts from the Treasurer of the United States, as per appropriation for fiscal year ending June 30, 1905, as per act of Congress approved March 2, 1887		$15,000.00

CR.

By salaries	$ 7,306.85	
Labor	1,246.63	
Publications	811.42	
Postage and stationery	227.20	
Freight and express	107.28	
Heat, light, water, and power	752.60	
Chemical supplies	317.86	
Seeds, plants, and sundry supplies	343.78	
Fertilizers	30.00	
Feeding stuffs	919.70	
Library	227.40	
Tools, implements, and machinery	415.93	
Furniture and fixtures	60.85	
Scientific apparatus	88.13	
Live stock	1,278.43	
Traveling expenses	364.07	
Contingent expenses	15.00	
Buildings and repairs	486.87	
Totals	$15,000.00	$15,000.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Ex-

periment Station for the fiscal year ending June 30, 1905; that we have found the same well kept and classified as above; and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

[Signed] A. J. MOKLER,
H. L. STEVENS,
HARRIET KNIGHT,
Auditors.

Attest:
GRACE RAYMOND HEBARD,
(SEAL) Custodian.

SUPPLEMENTARY STATEMENT.

DR.

	Farm Products.	*Total.*
To receipts from other sources than the United States for the year ending June 30, 1905	$604.30	$604.30

CR.

Heat, light, water, and power	$104.30	
Dry farming experiment	500.00	$604.30

Report of the Agriculturist and Horticulturist.

The report of the Director indicates the general lines of work which have been given prominence in the Agricultural Department, and the report of the Assistant in Animal Husbandry accompanying this tells what has been done with live stock investigations. The work being conducted by this department is largely continuous. Considerable bulletin material is on hand which we have not yet been able to prepare for publication. The work in this department has been more fully reorganized in order to lay more stress on the live stock problems of interest to the state. To that end the larger part of the farm was seeded to alfalfa, and thirteen acres of field pease are being grown for another experiment in lamb feeding by allowing them to pasture the pease instead of harvesting them. The investigations closed were those in irrigation which include the work of Mr. Fleming along the North Platte River, the results of which are published in Bulletin No. 66. Mr. Fleming has also prepared the manuscript for a bulletin which will report the duty of water investigations by the station, in order to finish the work as nearly as may be to date on account of his resignation as Irrigation Engineer. The work with live stock has been actively pursued, as stated in the report of the Director and as given in Mr. Morton's report herewith.

Work with breeding has been continued through the year with Polled Hereford cattle, Tamworth swine, and Rambouillet sheep. Brief trials were made with incubators for hatching chickens which met with some success. There is a belief that our high altitude is not favorable to incubating chickens.

The work with breeding horses was practically closed because of an outbreak of glanders and the destruction of three out of four brood mares which had been obtained. It has been thought wise not to attempt further horse work until more

money becomes available which can be used for new stock and better equipment.

In agronomy the principal work taken up, was some new experiments with barley. This is one of the most important grains raised in the state and detailed information of varieties suitable for feeding and brewing and their cropping systems promises to be of much value to our people. Experiments with potatoes have been continued to show the value of change of seed in avoiding damage by rhyzoctonia. The results have been various and unsatisfactory, so this work will have to be continued. Some new investigations have been inaugurated with Bokhara clover, the purpose being by breeding and methods of curing the hay to secure forage which will be palatable to stock. This plant has shown itself adaptable to dry lands and strongly alkalized soils. Its roots have always contained nodules, where adjoining alfalfa plants seem to have no nodules, which gives some indications of its value as a soil improver. A recent analysis of Bokhaha clover, of plants grown on the station farm, showed a protein content of 22 per cent, which is larger than any other forage plant we have analyzed. In trials with feeding Bokhara clover to lambs, they ate it greedily at first, but seemingly they began to tire of it after a few days. It is thought that it may be possible by some years of breeding to secure a variety without the strong flavors which make it unpalatable.

But little co-operation was carried out during the year. One experiment in which we had planted alfalfa and a mixture of grasses at an altitude of 8,400 feet ended in the failure of the alfalfa and a partial success of Awnless Brome-Grass. The land had been covered with sage-brush, but seemed very poor, and the cold, short season was detrimental to the alfalfa. A small amount of irrigation work was done in co-operation with the department, and some varieties of flax were grown in co-operation with the Division of Plant Introduction.

Extension work of the station has been in the nature of Short Courses at the University, a small amount of Farmers'

Institute work in other parts of the state, a large amount of correspondence, some supplying of seeds and general advice to our farmers and stockmen, papers and other help presented at state organizations of stockmen and farmers, and county and state fairs. This work has been supported by funds outside the station, but has taken some time of the station officers.

The plans for the year as outlined in the last annual report were modified somewhat, although they have been generally carried out. The irrigation work planned has largely been at a standstill because we could not early fill Mr. Fleming's place with a new man, and the co-operative work in reclamation and drainage with the Office of Experiment Stations was not carried out as it had been planned. This was because there were some new difficulties in the Department at Washington and also because the land upon which this work was to be conducted was not turned over to the station by the state on account of the error in the title of the bill passed by the Legislature, which caused the Governor to veto it. Instead of the irrigation and drainage work at the station we have co-operated in the dry farm experiments being carried on under the direction of Mr. Mead at Cheyenne, and gave $500 from our fund for that work.

The horticultural work was also modified by the new bill passed by the Legislature which gave $2,000 of state funds to pay for horticultural experiments at Lander. As horticulturist of the station, I was appointed on the new Experimental Commission in charge of this work, and visited Lander on April 7th. The other two members are Mr. J. M. Hornecker of Lander and Mr. Edward Young of Dallas. A plan was agreed upon to largely increase the planting of fruits on the Lander experiment farm. On April 13 I visited the Colorado nurseries at Loveland, Colorado, and placed an order for new fruit stock to be shipped to Lander. Where it was possible to obtain them, we bought both two and three-year-old trees of each variety of apples, and also some one-year-old stock to throw light on the best age at which to plant trees in our region.

These trees had to be shipped 128 miles by freight teams, and, on account of spring storms, there were delays, which caused much of the stock to dry out badly and reach Lander in poor condition. There were 99 different lots of fruit stock purchased at a cost of $137.86. Mr. Hornecker has direct charge of the planting and care of the fruits on the Lander farm. There are some twenty varieties of apples and several of pears, plums, and cherries fruiting from the old station planting of 1892 to 1895, and as our first station fruit bulletin is entirely out of print, we hope to gather data enough the coming season for a new general bulletin on this subject.

We have discovered the prevalence of two plant diseases which are causing serious loss. The alfalfa leaf spot disease (*Pseudopeziza medicaginis*) is reported to have destroyed whole fields of alfalfa in the North Platte Valley at the higher altitudes. It has been observed on our station farm at Laramie quite widely distributed through the fields.

The death of our cottonwood shade trees in Laramie seems to be due to a slime mould crown gall. Specimens sent to Prof. Paddock of the Colorado Station were reported back as crown gall by him. We find it widely distributed among the shade trees of Laramie, and, as the cottonwood is the only successful tree grown here, there is much interest in the new malady.

Report of the Assistant in Animal Husbandry.

STOCK-FEEDING EXPERIMENTS.

Ration experiments have been conducted with fattening lambs and with swine. The results of the lamb-feeding experiments have been published in Bulletin No. 68. They embrace a comparison of the following rations:

1. Alfalfa, corn, turnips.
2. Alfalfa, barley, turnips.
3. Native hay, corn, turnips.
4. Alfalfa, corn, turnips, flaxseed.
5. Alfalfa, flaxseed.

A summary will be found further on in this report.

The swine-feeding experiments embrace the following comparisons:

1. Wheat.
2. Corn.
3. Wheat, alfalfa hay.
4. Wheat, alfalfa hay, roots.

   Stock hog—holding over winter on alfalfa hay and roots without grain.

Growing pigs:

1. Alfalfa hay, wheat.
2. Alfalfa hay, wheat, roots.

Feeding pigs just after weaning:

1. Corn, shorts.
2. Corn, alfalfa hay dry.
3. Wheat, alfalfa hay in swill.
4. Corn, alfalfa hay in swill.

   Feeding mature sows a ration consisting of about one-third alfalfa hay and two-thirds grain.

Full accounts of the results of these experiments will appear in a swine bulletin some time during the coming year. A summary is presented herewith.

DIGESTION EXPERIMENTS.

Conducted in co-operation with the Department of Chemistry.

Two grade Rambouillet wethers were used for these experiments, and trials were conducted with the following forage plants:

1. Western Wheat-Grass—two trials.
2. Alfalfa, first cutting—two trials.
3. Alfalfa, second cutting—four trials.
4. Native hay—mixed grasses—two trials.

The results of this work will be found in Bulletin 69 of this station.

BREEDING EXPERIMENTS.

The work of developing the double standard Polled Hereford breed by use of a polled bull upon horned cows has been continued. A crop of calves is due in the near future. A herd of twelve pure-bred Hereford cows are being used in the work.

Weights of lambs and pigs dropped at the college farm, and of their dams and sires, are being recorded with a view to casting additional light upon the problem of the relative influence of sire and of dam upon the offspring.

Breeding experiments with guinea-pigs were begun, but were brought to a close through the destruction of the breeding flock by coyotes.

POULTRY EXPERIMENTS.

A ration experiment with fattening poultry, and an incubator experiment with ranch eggs, both resulted unfavorably.

LIVE STOCK ACQUISITIONS.

Sheep work has been inaugurated by the purchase of seventeen pure-bred Rambouillet ewes and three Franco-American ewes.

The Hereford breeding herd has been increased by the purchase of eight Hereford heifers, bred to a Double Standard Polled Hereford bull.

SUMMARY OF LAMB FEEDING, 1904-05.

Sixty-six lambs were divided into three lots of twenty lambs each and two lots of three lambs each, as follows:

TABLE I.

Lot	Number	Breeds	Average weight		*Grain ration	Roughage
			Shrop.	Merino		
1. .	20 lambs	10 Shrop., 10 Merino	67.3 lbs.	58.0 lbs.	Corn	Alfalfa
2. .	20 "	10 " 10 "	67.2 "	57.3 "	Barley	Alfalfa
3. .	20 "	10 " 10 "	67.5 "	57.9 "	Corn	Native hay
4. .	3 "	1 " 2 "	78.0 "	59.0 "	Corn and flaxseed	Alfalfa
5. .	3 "	1 " 2 "	80.0 "	57.5 "	Flaxseed	Alfalfa

*All lots were fed turnips in addition to the above rations.

It will be seen by the above data that the three lots of twenty each were fairly divided as regards breed and weight, and presumably thrift; and the same is true of the two lots of three each. In the discussions following, comparisons between any two lots containing originally the same number of lambs are, therefore, legitimate.

By means of Lots 1, 2, and 3, we may directly compare corn with barley and native hay with alfalfa as feeds for fattening lambs. And by a comparison of feed and gains of Lots 4 and 5, we may learn the value of flaxseed as a substitute for the ordinary grain ration with alfalfa. The lambs were fed from October 16th, 1904, to February 4th, 1905, or 16 weeks.*

TABLE II.—*Feed and Gain per Head, Sixteen Weeks.*

Lot	Ration, including turnips	Average feed per head, pounds						Average gain per head
		Alfalfa	Native hay	Corn	Barley	Turnips	Ground flaxseed	
1. .	Alfalfa, corn	192	. . . .	85	. . .	130	. . . .	31.2
2. .	Alfalfa, barley	191	. . . .	. . .	90	179	. . . .	33.1
3. .	Native hay, corn	. . . .	151	83	. . .	51	. . . .	20.7
4. .	Alfalfa, corn, and flaxseed	143	. . .	89	. . .	205	7.3	31.8
5. .	Alfalfa, flaxseed	204	. . . .	. . .	. . .	426	19.0	25.7

*ERRATA.—Bulletin 68 gives Feb. 21st as the closing date of the experiment.

TABLE III.—*Cost of 100 Pounds Gain, and Nutritive Ratio.*

Lot	Ration, including turnips	Cost of 100 lbs. gain: Turnips at $1 per ton	Cost of 100 lbs. gain: Turnips at $2 per ton	Nutritive ratio
1. . .	Alfalfa, corn	$4.47	$4.68	1: 4.8
2. . .	Alfalfa, barley	4.45	4.72	1: 4.8
3. . .	Native hay, corn	5.96	6.08	1: 10.5
4. . .	Alfalfa, corn, and flaxseed	4.55	4.86	1: 5.1
5. . .	Alfalfa, flaxseed	4.30	5.13	1: 4.2

Compiled from Tables II and XVII.

DIGESTIBLE NUTRIENTS FOR GAIN.

The following table gives some information of interest in connection with the nutritive ratio:

TABLE IV.

Lot	Ration, including turnips	Gain per head, pounds	Pounds digestible nutrients for 100 lbs. gain: Protein	Pounds digestible nutrients for 100 lbs. gain: Carbohydrates and fat (Factor 2.4)	Nutritive ratio
1. . .	Alfalfa, corn	31.2	103	490	4.8
2. . .	Alfalfa, barley	33.1	97	470	4.8
3. . .	Native hay, corn	20.7	68	710	10.5
4. . .	Alfalfa, corn, and flaxseed	31.8	88	451	5.1
5. . .	Alfalfa, flaxseed	25.7	126	525	4.2

Compiled from Table XVII.

TABLE V.—*Yield of Lambs.*

Lot	Breed	Live weight, lbs.	Dressed weight, lbs.	Percent dressed	Weight of pelt, lbs.	Wt. of caul fat, lbs.
1. . . .	Shrop.	92	48	52	16	3.5
2. . . .	Shrop.	116	68	58	14	3.3
3. . . .	Shrop.	92	48	52	15	2.0
5. . . .	Shrop.	103	54	54	16	5.5

TABLE VI.—*Weekly Data, Lot I.*
(Twenty lambs in lot.)

	Weight, lbs.	Gain, lbs.	Average gain per head, lbs.	Feed, lbs. Alfalfa	Feed, lbs. Corn	Feed, lbs. Turnips	Notes
Beginning	1253	...	...	...	...	...	...
1st week	1312	59	2.95	266	...	...	...
2d "	1351	39	1.95	353	...	...	...
3d "	1356	5	.25	354	.75	18	...
4th "	1368	12	.6	283	10.75	67	...
5th "	1452	84	4.2	210	78.75	191	...
6th "	1511	59	2.95	195	140	304	...
7th "	1519	8	.4	149	132	331	Off feed
8th "	1538	19	.95	250	140	125	Turnips reduced
9th "	1625	87	4.35	229	140	140	...
10th "	1656	31	1.55	238	140	140	...
11th "	1682	26	1.3	238	140	158	...
12th "	1739	57	2.85	238	140	224	...
13th "	1766	27	1.35	238	150	226	...
14th "	1798	32	1.6	238	162	224	...
15th "	1820	22	1.1	193	149	224	...
16th "	1878	58	2.9	168	175	224	...
Total	...	625	31.25	3840	1698	2596	...

TABLE VII.—*Weekly Data, Lot II.*
(Twenty lambs in lot.)

	Weight, lbs.	Gain, lbs.	Average gain per head, lbs.	Feed, lbs. Alfalfa	Feed, lbs. Barley	Feed, lbs. Turnips	Notes
Beginning	1245	...	...	...	...	...	...
1st week	1322	77	3.85	266	...	...	...
2d "	1400	78	3.9	353	...	...	...
3d "	1407	7	.35	316	7	44	...
4th "	1414	7	.35	283	35	83	...
5th "	1492	78	3.9	210	109	202	...
6th "	1569	77	3.85	210	140	334	...
7th "	1577	8	.4	190	133	366	Off feed
8th "	1609	32	1.6	210	140	402	...
9th "	1629	20	1.0	229	140	315	...
10th "	1660	31	1.55	238	140	210	...
11th "	1694	34	1.7	238	140	227	...
12th "	1749	55	2.75	238	140	280	...
13th "	1767	18	.9	240	151	282	...
14th "	1807	40	2.0	238	170	280	...
15th "	1836	29	1.45	193	175	280	Alfalfa reduced that more grain might be eaten
16th "	1906	70	3 5	168	187	280	...
Total	...	661	33.05	3820	1807	3585	...

TABLE VIII.—*Weekly Data, Lot III.* (Twenty lambs in lot.)

	Weight, lbs.	Gain, lbs.	Average gain per head, lbs.	Feed, lbs.* Native hay	Corn	Turnips	Notes
Beginning	1254	. . .	. . .	. . .	. . .	. . .	. . .
1st week	1307	53	2.65	166	. . .	. . .	. . .
2d "	1268	—39	—1.95	121	. . .	. . .	. . .
3d "	1290	22	1.1	174	45	73	7 lambs scouring and off feed for an average of 5 days each†
4th "	1335	45	2.25	226	85	94	2 lambs ditto†
5th "	1382	47	2.35	144	122	179	. . .
6th "	1383	1	.05	130	83	85	Off feed
7th "	1418	35	1.75	180	98	117	. . .
8th "	1429	11	.55	210	114	135	. . .
9th "	1481	52	2.6	226	106	0	Off feed
10th "	1518	37	1.85	238	137	40	. . .
11th "	1513	—5	—.25	216	140	42	. . .
12th "	1587	74	3.7	210	140	42	. . .
13th "	1607	20	1.0	213	148	46	. . .
14th "	1611	4	.2	210	142	56	. . .
15th "	1634	23	1.15	183	148	57	. . .
16th "	1668	34	1.7	168	152	56	. . .
Total	. . .	414	20.7	3015	1660	1022	. . .

*Some of the lambs in this lot were usually scouring. The turnips and eventually the hay had to be cut down to keep them eating the corn. They never at any time relished the ration

†These nine sick lambs were removed and fed alfalfa and corn until they came back on feed.

TABLE IX.—*Weekly Data, Lot IV.* (Three lambs in lot.)

	Weight, lbs.	Gain, lbs.	Average gain per head, lbs.	Feed, lbs. Alfalfa	Corn	Turnips	Ground flaxseed	Notes
Beginning	196	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1st week	204	8	2.7	46	. . .	. . .	. . .	. . .
2d "	221	17	5.7	56	. . .	. . .	. . .	. . .
3d "	222	1	.3	45	10	10	.88	. . .
4th "	221	—1	—.3	34	19	23	1.88	. . .
5th "	232	11	3.7	14	21	45	1.75	. . .
6th "	241	9	3.0	14	21	58	1.75	. . .
7th "	245	4	1.3	14	21	70	1.75	. . .
8th "	250	5	1.7	23	21	59	1.75	. . .
9th "	255	5	1.7	34	19	19	1.19	Off feed
10th "	261	6	2 0	20	15	33	1.38	. . .
11th "	260 (3) 167 (2)	—1	—.5	14	21	42	1.75	. . .
12th " *	172	5	2 5	15	16	32	1.13	. . .
13th "	177	5	2.5	15	14	30	.88	. . .
14th "	178	1	.5	14	9	35	.88	. . .
15th "	180	2	1.0	14	9	31	.88	. . .
16th "	188	8	4.0	14	11	28	.82	. . .
Totals	. . . .	85	31.8	386	227	515	18.67	. . . .

*One Shrop-cross died January 2 of congestion of the lungs. Weight, 93 lbs.

TABLE X.—*Weekly Data, Lot V.*
(Three lambs in lot.)

	Weight, lbs.	Gain, lbs.	Average gain per head, lbs.	Feed, lbs. Alfalfa	Turnips	Ground flaxseed	Notes
Beginning	195	. . .	. . .	. . .	. . .	. . .	. . .
1st week	205	10	3.33	46	. . .	. . .	. . .
2d "	225	20	6.67	56	. . .	. . .	. . .
3d "	204	—21	—7.0	46	7	. . .	Turnips not eaten
4th "	216	12	4.0	32	12	. . .	Began eating turnips
5th "	217	1	.33	43	50	3	. . .
6th "	229	12	4.0	42	77	3.5	. . .
7th "	234	5	1.67	42	101	3.5	. . .
8th "	237	3	1.0	42	112	5.75	. . .
9th "	241	4	1.33	42	112	6.5	. . .
10th "	248	7	2.33	42	112	7.0	. . .
11th "	250	2	.67	40	112	6.25	. . .
12th "	256	6	2.0	28	114	3.5	. . .
13th "	257	1	.33	28	114	3.5	. . .
14th "	258	1	.33	28	111	3.5	. . .
15th "	264	6	2.0	28	119	4.0	. . .
16th "	272	8	2.67	28	125	7.0	. . .
Totals	. . .	77	25.66	613	1278	57.0	. . .

TABLE XI.—*Feed, All Lots.*
(Compiled from Tables VI to X.)

Lot	No. in lot	Total feed for 16 weeks, lbs. Alfalfa	Native hay	Corn	Barley	Turnips	Ground flaxseed	Av. feed per head, 16 wks., lbs. Alfalfa	Native hay	Corn	Barley	Turnips	Ground flaxseed
1	20	3840	. . .	1698	. . .	2596	. . .	192	. . .	85	. .	130	. . .
2	20	3820	. . .	. . .	1807	3585	. . .	191	. . .	. .	90	179	. . .
3	20	. . .	3015	1660	. . .	1022	. . .	. . .	151	83	. .	51	. . .
4	3*	386	. . .	227	. . .	515	18.7	143	. . .	89	. .	205	7.3
5	3	613	. . .	. . .	. . .	1278	57.0	204	. . .	. .	. .	426	19

*1 died during the 12th week. The average feed is obtained by adding the average for three lambs for eleven weeks to the average for two lambs for five weeks.

TABLE XII.—*Weights and Gains, All Lots.*
(Compiled from Tables VI to X.)

Lot	Initial weight, lbs.	No. in lot	Closing weight, lbs.	No. in lot	Total gain, lbs.	Average gain per head, lbs.
1	1253	20	1878	20	625	31.2
2	1245	20	1906	20	661	33.1
3	1254	20	1668	20	414	20.7
4	196	3	188	2	85	31.8
5	195	3	272	3	77	25.7

TABLE XIII.—*Feed Required for Gain, All Lots.*
(Compiled from Tables XI and XII.)

Lot	Ration, including turnips	Gain per head	Pounds feed for 100 pounds gain					
			Alfalfa	Native hay	Corn	Barley	Turnips	Ground flaxseed
1	Alfalfa, corn	31.2	614	....	272	....	415	..
2	Alfalfa, barley	33.1	578	....	....	273	542	..
3	Native hay, corn	20.7	....	728	401	....	247	..
4	Alfalfa, corn, flaxseed	31.8	454	....	267	....	606	22
5	Alfalfa, flaxseed	25.7	796	....	....	....	1660	74

TABLE XIV.—*Composition of the Feeding Stuffs.*

	Water	Ash	Crude protein	Crude fibre	Nitrogen free extract	Ether extract
Alfalfa*	5.80	9.23	15.16	33.55	34.78	1.48
Native hay	5.67	7.29	7.19	31.65	45.17	3.03
Corn	11.08	1.64	11.31	2.42	70.58	2.97
Barley	11.36	3.01	11.38	7.04	65.42	1.79
Flaxseed	7.44	4.31	19.38	6.36	31.08	31.43

*Average of two analyses.

Analyses made by Mr. F. E. Hepner, Assistant Chemist of the Experiment Station.

TABLE XV.—*Digestibility of the Feeding Stuffs.*

	Protein	Crude fibre	Nitrogen free extract	Ether extract
Alfalfa	79.67	44.63	74.22	41.12
Native hay	58.77	67.27	67.19	40.79
Corn	76	58	93	86
Barley	70	50	92	89
Flaxseed	91	61	55	86

The coefficients of digestibility for the alfalfa and native hay are from digestion experiments conducted by the Chemistry and Animal Husbandry Departments of this station, not yet published. The coefficient for corn is from Zusammensetzung der Futtermittel, Dietrich, and König. The other two are from Mentzel and Lengerke's Landn. Kalender for 1898, through Henry's Feeds and Feeding.

TABLE XVI.—*Digestible Nutrients in the Feeding Stuffs.*

(Compiled from Tables XIV and XV, except the figures for turnips, which are from "Feeds and Feeding"—Henry.)

	Digestible nutrients in 100 lbs.		
	Protein	Carbo-hydrates	Ether extract
Alfalfa	12.08	40.76	.61
Native hay	4.23	51.65	1.24
Corn	8.6	67.0	2.6
Barley	8.0	63.7	1.6
Turnips	1.0	7.2	0.2
Flaxseed	17.6	21.0	27.0

TABLE XVII.—*Amount of Digestible Nutrients Eaten.*
(Compiled from Tables XI and XVI.)

Lot	Protein	Carbo-hydrates	Ether extract	Nutritive ratio (Factor 2.4)
1	642	2890	72	4.77
2	642	2966	59	4.84
3	281	2743	82	10.46
4	75	350	14	5.11
5	97	354	21	4.16

SOME COMPARISONS AND CONCLUSIONS.

Lot. *Ration.*

1. Alfalfa, corn, turnips.
2. Alfalfa, barley, turnips.
3. Native hay, corn, turnips.
4. Alfalfa, corn, turnips, flaxseed.
5. Alfalfa, turnips, flaxseed.

The barley-fed lambs made best gains. They required less digestible nutrients for gain than either Lot 1 or Lot 3. They were kept on high feed with least trouble. The barley-fed lambs dressed out the highest percentage.

The corn-alfalfa lambs were close seconds to the barley lambs. Under slightly differing conditions, they might have done better than the barley lambs. The test was practically a tie between these two lots.

The lambs fed upon native hay and corn made the poorest gains. The nutritive ratio was too wide. Some lambs were at all times scouring. The lamb slaughtered dressed out well. Native hay low in protein should not be used with corn for feeding. Feeders using native hay of unknown composition should have it analyzed in order to know how much protein it contains.

Lot 4 made good gains. They took a very low amount of digestible nutrients for gain. Flaxseed may be used in place of flaxseed meal to supplement the corn ration. This experiment showed no marked benefit from the addition of flaxseed to the corn ration.

Lot 5 made medium gains.

They grew fat without cereal grains.

They ate much more alfalfa than other lots, thus putting on gain with cheap feed.

The nutritive ratio was too narrow.

The lamb slaughtered dressed better than the corn-fed lamb.

The meat was off color, but of excellent flavor.

Flaxseed may be fed heavily without expressing the oil, and no urinary trouble results therefrom.

Alfalfa, flaxseed, and turnips would make a good ration for a farmer feeder who could not obtain corn or barley cheaply.

SUMMARY OF SWINE FEEDING, 1904-1905.

RATION EXPERIMENT A.

Corn vs. Wheat for fattening.

Lot	Number in lot	Weight at beginning	Weight after 11 weeks	Gain	Feed	Amount fed per day	
						At beginning	At close
1.	3	251	593	342	Wheat	10 lbs.	24 lbs.
2.	3	247	476	229	Corn	10 lbs.	24 lbs.

Many ranchmen in Wyoming think corn is necessary to pork production. The above experiment proves by local demonstration what is acknowledged in many other communities, namely: that wheat will put more meat on growing hogs than corn.

The wheat fed was grown on the Laramie Plains, and was shrunken by frost. The corn was shipped in from Western Nebraska. The hogs averaged 84 and 82 pounds per head at the beginning of the experiment, and in eleven weeks' feeding the wheat-fed hogs averaged 40 pounds per head heavier than the corn-fed hogs, weighing on the average nearly 200 pounds each.

The swine used were pure-bred Tamworths, but the fact that they really fattened as well as put on weight will be shown in a forthcoming bulletin, publishing with the data in full cuts of carcasses from one of the Tamworths used in the experiment, and from a fat Poland-China hog.

Both lots were fed as much as they would eat and a comparison of the feed for gain will be given in the bulletin.

RATION EXPERIMENT B.

A comparison of two rations containing alfalfa hay.

Lot	No. in lot	Weight at beginning	Weight after 13 weeks	Gain	Feed per day					
					At beginning			At close		
					Wheat	Alfalfa	Roots	Wheat	Alfalfa	Roots
3....	2	197	380	183	6	6	4	8	6	6
4....	2	198	383	185	6	6	....	8	6	....

The alfalfa hay was fed whole in specially constructed racks.

The amount of wheat was increased as soon as the hogs would eat an additional amount without leaving their hay or roots. The increase from six to eight pounds was made the middle of the sixth week of feeding. The lots gained evenly and neither distanced the other. They apparently did not fatten, but kept in good thrift and grew rapidly.

Evidently the roots fed did no good in any way; they were simply an additional expense.

The gains made indicate that growing pigs of 90 pounds or upward in weight will make satisfactory gains upon a ration of approximately one-half wheat and one-half alfalfa hay.

COMPARISON OF EXPERIMENTS A AND B.

Experiments A and B were contemporaneous, were conducted with pigs from the same litters, and the wheat fed was from the same bin. Therefore, the first eleven weeks of each experiment may be compared:

Lot	No. in lot	Average weight at beginning	Average weight at 11 weeks	Average gain per head	Average Feed per Head Each Day—Pounds							
					At the beginning				At the close			
					Corn	Wheat	Alfalfa hay	Roots	Corn	Wheat	Alfalfa hay	Roots
1......	3	84	198	114	...	3⅓	...	...	...	8	...	...
2......	3	82	159	77	3⅓	...	...	...	4⅔	...	...	...
3......	2	99	183	84	...	3	3	2	...	4	3	3
4......	2	99	184	85	...	3	3	...	...	4	3	...

Lots 3 and 4, having alfalfa hay as part of the ration, made better gains than Lot 2, fed corn. They consumed less grain per head than the corn-fed hogs. An answer to the question whether this extra gain and less amount of concentrates is offset by the cost of the alfalfa hay depends upon the comparative cost of the feeds in a given locality.

Straight wheat feeding gives the best gains of any of the rations tabulated, but it also involves very heavy grain feeding to get the gain.

RATION EXPERIMENT C.

Wintering stock sow on alfalfa hay and roots. A Tamworth sow weighing 341 pounds at the beginning of the experiment, on December 3, was fed only alfalfa hay and roots for 14 weeks. She consumed six pounds of alfalfa hay each day throughout the experiment, an amount of roots ranging from six pounds per day at the beginning of the experiment to twenty-four pounds at the close. She weighed 334 pounds on March 11, her weight having been fairly constant at about that point for several weeks.

So nominal a loss as seven pounds in 14 weeks speaks well for the possibilities of running stock hogs through the winter on alfalfa hay and roots.

RATION EXPERIMENT D.

Feeding breeding sows a ration of corn, shorts, and alfalfa hay.

No. in lot	Weight at beginning	Weight at end of 6 weeks	Gain	Feed per day at beginning			Feed per day at close		
				Corn	Shorts	Alfalfa	Corn	Shorts	Alfalfa hay
3.	1073	1195*	122	6	10	7	10	10	10

*Actual weight of sows 1242 ponnds, minus 47 pounds, the weight of the litters dropped by two of the sows one week after the experiment closed. The third sow proved to be without pigs.

The gain shown by the table is good and the sows were apparently put in good condition for pigging by this ration. One sow gave birth to seven living pigs and one dead pig; the

other gave birth to five living and three dead. Further experimentation will be required to determine whether the ration was responsible for the still births.

RATION EXPERIMENT E.

A comparison of rations for pigs averaging 65 lbs. in weight.

Lot	No. in lot	Weight at beginning	Weight after 4 weeks	Ration
1.	3	190	251	⅓ corn, ⅔ shorts
2.	3	200	219	⅓ corn, ⅔ alfalfa hay, dry
3.	3	194	191	⅓ wheat, ⅔ alfalfa hay, chopped, in swill
4.	3	190	187	⅓ corn, ⅔ alfalfa hay, chopped, in swill

The alfalfa rations for young growing pigs were lamentable failures. The pigs grew scrawny and lost weight. One in Lot 2 died suddenly, apparently from digestive troubles, and the experiment was at once discontinued.

Report of the Chemist.

During the past year the station work in this department has been reorganized, making it possible to carry on a series of investigations without interruption.

At the beginning of the year it was decided to increase the force, that more efficient work might be done, and the 1st of October, 1904, Mr. Frank E. Hepner took the position of Assistant Station Chemist. Mr. Hepner comes to us from the South Dakota Agricultural College, and has received excellent training under the guidance of Prof. James Shepard, who has charge of the station work in chemistry for that station. All of Mr. Hepner's time is devoted to agricultural research, so that the station work can be carried on continuously.

A part of the room in the food laboratory was set apart temporarily for the investigations along the line of agricultural chemistry until another laboratory could be fitted up for agricultural chemical research exclusively. This is now being done, and it is hoped that everything will be in readiness by the 1st of September, 1905.

We have been handicapped somewhat during the past year because of the close quarters, still considerable work has been accomplished.

Several lines of investigation have been taken up and will be discussed under the following heads:

I. *Forage Plant Investigations.*

II. *Digestion Experiments with Forage Plants.*

III. *Alkali Studies.*

Most of the time of the station staff in this department has been devoted to investigations embodied under heads I and II, as given above.

I. FORAGE PLANT INVESTIGATIONS.—The Wyoming Experiment Station is peculiarly situated, being at such a high altitude and in a portion of the United States which is popularly known as the Great American Desert; and it is highly probable that many of the problems which have been

worked upon by other stations must be worked over along very similar lines at this station because of the peculiar conditions existing here. It may be well to give some of our reasons for taking up certain problems at the present time, and these will be enumerated below for the subject under immediate discussion:

First—Practically nothing has been known concerning the chemical composition of forage plants grown under arid conditions and at a high altitude, but it has generally been supposed by stock feeders that the native forage plants, at least, are highly nutritious—containing in large amounts those constituents which are desirable and costly for the Eastern stock feeder to get into the foods in sufficient quantities.

Second—Many of our native forage plants peculiar to the Rocky Mountain regions have never been investigated.

Third—Ranchmen in this section of the state make a practice of flooding the hay meadows to such an extent during the irrigation season that the native and introduced grasses are drowned out for the greater part and are replaced by the native rushes and sedges. Probably a greater weight of dry hay made from these rushes and sedges is obtained than could be procured if the meadows were irrigated in such a manner that the hay grasses would grow, but the comparative nutritive values are not known. At low altitudes the rushes and sedges are not considered as nutritious as are the grasses; on the other hand, it is claimed by many that the Wyoming native rushes and sedges are highly nutritious, and, although stock will pass them by for the grasses while green, after they are cured the stock relish the hay and thrive well upon it.

Fourth—As we intend to carry on a series of digestion experiments with the native forage plants cured as hay, the chemical composition alone will give us a clue as to which are really of value for feeding purposes and which will be most profitable to take up first in our future work.

Fifth—From a scientific standpoint it will be of value to know the variation produced (if any) in the composition of

introduced forage plants by the quite marked change in the environment to which they are subjected.

During the past year Bulletin No. 65, "Wyoming Forage Plants and Their Chemical Composition—Studies No. 1," was published, giving the results accomplished in this field of work up to date.

Below is given a table containing the analyses of forage plants, native and introduced, which are included in Bulletin

NAME	GREEN					
	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Eriocoma cuspidata Nutt. Indian Millet	56.08	3.10	0.79	13.72	5.41	20.90
Agropyron occidentale Scribn. Western Wheat-grass	56.50	3.73	0.92	13.78	5:00	20.07
Ditto. (Not so coarse as above)	53.73	4.93	0.77	15.37	4.21	20.99
Agropyron tenerum Vasey. Slender Wheat-grass	57.88	3.18	0.81	14.30	2.88	20.95
Agropyron caninum (L.) R. & S. Bearded Wheat-grass	58.29	3.46	0.82	15.28	3.28	18.87
Agropyron dasystachyum (Hook.) Scribn. Northern Wheat-grass	44.45	3.66	1.56	21.44	4.31	24.58
Agropyron pseudorepens S. & S. Western Couch-grass	48.51	3.74	1.01	20.02	3.50	23.22
Deschampsia caespitosa Beauv. Tufted Hair-grass	57.28	3.76	0.68	15.31	3.31	19 66
Poa Buckleyana Nash. Buckley's Spear-grass	53.84	3.18	0.79	16.64	2.84	22.71
Poa lucida Vasey Yellow Spear-grass	48.47	3.86	1.49	18.75	4.78	22.65
Bromus ciliatus L. Fringed Brome-grass	62.49	2.88	0.83	13.21	4.10	16.49
Puccinellia airoides (Nutt.) Wats. & Coult. Alkali Meadow-grass	48.43	4.34	0.92	17.24	3.36	25.71
Stipa Nelsonii Scribn. Nelson's Needle-grass	44.41	4.51	1.59	19.04	5.14	25.31
Astragalus Bodini Sheld. Bodin's Vetch	83.34	2.01	0.22	3.77	3.42	7.24
Astragalus elegans (Hook.) Britt. Pretty Milk Vetch	74.98	1.98	0.36	8.33	4.74	9.61
Eurotia lanata Moq. Winter Fat. July 15th	57.76	4.75	0.65	14.41	7.22	15.21
Ditto. Sept. 17th	46.56	4.34	1.27	16.96	8.63	22.24
Festuca scabrella Torr. Rough Fescue	57.03	4.55	0.60	15.29	4.02	18.51
Hedysarum philoscia A. Nels. Woodland Hedysarum	69.97	2.04	0.34	6.73	5.40	15.52
Juncus Balticus Willd. Wire-grass or Baltic Rush	72.02	2.04	0.40	9.50	3.51	12.44
Hordeum jubatum L. Squirrel-tail grass. Sample of hay. (Cut when quite green)	...	...	...	...	...	...
Atriplex Nuttallii Wats. Nuttall's Salt-bush. July 15th	73.06	3.71	0.22	4.43	4.70	13.88
Ditto. Sept. 17th	Gree	n we	ight	not r	ecord	ed.
Atriplex halimoides Tineo	82.23	5.39	0.24	2.67	3.16	6.31
Atriplex holocarpa Muel.	85.40	4.41	0.19	2.46	2.73	4.81
Atriplex semibaccata R. Br. Australian Salt-bush	78.86	4.28	0.26	4.06	3.48	9.06
Atriplex volutans A. Nels. Tumbling Salt-bush	78.87	3.90	0.20	6.27	2.86	7.90
Melilotus alba Desv. Sweet or Bokhara Clover	79.35	2.10	0.53	4.78	3.96	9.28
Native Hay. (Mostly Western Wheat-grass)		S	amp	le of	hay	
Medicago sativa L. Alfalfa. No. 1. Second cutting			"	"	"	
Ditto. No. 2. Second cutting			"	"	"	
Ditto. No. 3. " "			"	"	"	
Ditto. No. 4. " "			"	"	"	
Ditto. No. 5. " "			"	"	"	
Ditto. No. 6. " "			"	"	"	
Ditto. No. 7. " "			"	"	"	
Ditto. (Average of seven above)	...	...	...	...	...	...

No. 65. The plants for the most part were collected by Mr. Elias Nelson, under the direction of Dr. E. E. Slosson, during the summer of 1901. All were collected while in bloom except those in the table indicated otherwise. The green weights were taken from Dr. E. E. Slosson's figures. As they were weighed as soon as they were brought into the laboratory, the interval between collecting and weighing being short, the loss in weight would not be appreciable:

AIR DRY						WATER FREE					
Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	
per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	
5.57	6.66	1.71	29.50	11.63	44.93	7.05	1.81	31.24	12.32	47.58	Gathered on University Campus, July 14
5.40	8.12	1.99	29.96	10.88	43.65	8.62	2.10	31.67	11.50	46.11	" " " " " 14
4.60	10.16	1.58	31.69	8.69	43.28	10.65	1.66	33.22	9.11	45.36	" " " " " 14
5.71	7.11	1.81	32.02	6.44	46.91	7.54	1.92	32.96	6.81	50.77	" " Experiment Farm, " 13
5.25	7.87	1.85	34.72	7.44	42.87	8.31	1.95	36.64	7.85	45.25	" " " " " 13
4.84	6.27	2.67	36.73	7.38	42.11	6.59	2.81	38.60	7.76	44.24	" " Laramie Hills, " 17
4.39	6.94	1.87	37.18	6.50	43.12	7.26	1.96	38.89	6.80	45.09	" " " " " 20
5.64	8.30	1.51	33.81	7.32	43.42	8.80	1.60	35.83	7.76	46.01	" " Experiment Farm, " 13
5.32	6.53	1.62	34.13	5.82	46.58	6.90	1.71	36.05	6.15	49.19	" " " " " 13
4.28	7.17	2.77	34.83	8.88	42.07	7.40	2.89	36.39	9.28	43.95	" " Laramie Hills, " 17
4.45	7.34	2.11	33.66	10.44	42.00	7.68	2.21	35.23	10.94	43.94	" " Experiment Farm, " 13
5.03	7.99	1.69	31.75	6.19	47.35	8.41	1.78	33.43	6.52	49.86	" " Penitentiary " " 13
4.67	7.74	2.72	32.65	8.81	43.41	8.12	2.85	34.25	9.24	45.54	" " Laramie Hills, " 17
5.81	11.38	1.27	21.30	19.31	40.93	12.08	1.35	22.61	20.50	43.46	" in City Park, " 15
5.62	7.46	1.36	31.43	17.88	36.25	7.90	1.44	33.30	18.94	38.42	" on Laramie Hills, " 20
9.64	10.15	1.40	30.83	15.44	32.54	10.91	1.50	33.13	16.59	37.87	" " University Campus, " 15
6.32	7.61	2.23	29.73	15.13	38.98	8.12	2.38	31.74	16.15	41.61	" " " " Sept. 17
4.51	10.11	1.34	33.98	8.94	41.12	10.64	1.40	35.58	9.36	43.02	" " Laramie Hills, July 20
7.08	6.32	1.05	20.83	16.69	48.03	6.80	1.13	22.42	17.96	51.69	" " " " " 20
6.75	6.80	1.32	31.96	11.69	41.48	7.29	1.42	34.27	12.54	44.48	" " Expt. Farm, July 11, 1904
4.50	7.53	2.08	33.28	7.19	45.42	7.88	2.18	34.85	7.53	47.56	" by Mr. J. S. Atherly, Aug. 1, '04
5.09	13.06	0.78	15.61	16.56	48.90	13.76	0.82	16.45	17.45	51.52	" on University Campus, July 15
5.71	14.18	1.29	29.71	11.31	37.80	15.04	1.37	31.51	11.99	40.09	" " " " Sept. 17
4.81	28.90	1.28	14.28	16.94	33.79	30.36	1.34	15.00	17.81	35.49	" " Experiment Farm, " 11
5.66	28.49	1.20	15.91	17.63	31.11	30.20	1.27	16.86	18.69	32.98	" " " " " 11
5.75	19.10	1.15	18.11	15.50	40.39	20.27	1.22	19.21	16.45	42.85	" " " " " 11
6.21	17.33	0.87	27.82	12.69	35.08	18.47	0.93	29.66	13.53	37.41	" " " " " 11
6.02	9.57	2.42	21.77	18.00	42.22	10.18	2.52	23.16	19.15	44.99	" " Expt. Farm, Oct. 4, 1904
5.67	7.29	3.03	31.65	7.19	45.17	7.73	3.21	33.55	7.62	47.89	
6.23	8.19	1.49	37.75	13.00	33.34	8.73	1.59	40.26	13.86	35.56	" " Experiment Farm
5.83	10.28	1.46	29.35	17.32	35.76	10.92	1.55	31.17	18.39	37.97	" " " "
6.45	7.91	1.44	34.99	13.13	36.08	8.46	1.54	37.40	14.04	38.56	" " " "
5.50	7.88	1.51	33.71	14.06	37.34	8.34	1.60	35.67	14.88	39.51	" " " "
6.46	8.50	1.56	31.13	15.13	37.22	9.09	1.67	33.28	16.17	39.79	" " " "
6.60	8.17	1.42	33.06	14.06	36.69	8.75	1.52	35.40	15.05	39.28	" " " "
6.70	8.87	1.69	27.36	15.88	39.50	9.51	1.81	29.32	17.02	42.34	
6.19	8.54	1.51	32.48	14.65	36.63	9.10	1.61	34.62	15.62	39.05	

It is the intention to carry on the work in the future until most of the common range grasses and other forage plants, both native and introduced, which are of importance, have been investigated. This to be followed as rapidly as possible with digestion experiments.

II. DIGESTION EXPERIMENTS WITH FORAGE PLANTS.—It has been the desire of the Director of the station for a number of years past to have digestion experiments carried on at this station, but it was not until during the past year that arrangements could be made to take up the work with any degree of satisfaction. The reasons for taking up the work may be enumerated as follows:

First—It is not believed that the digestion coefficients that have been worked out for Eastern grasses will apply to the native grasses of Wyoming.

Second—The knowledge of the digestion coefficients of our native hays will be of value in making up feeding rations.

Third—The question is often brought to us, what effect does altitude and arid conditions have upon the digestibility of forage plants? To answer this question, in a measure investigations have been taken up with alfalfa. The digestion coefficients for this plant have been worked out by a number of the stations situated at a low altitude and, as the plant thrives well here, it will be comparatively easy to obtain data and make comparisons.

It is highly probable that plants grown under arid conditions at a high altitude will give different digestion coefficients than those grown at a low altitude under humid conditions. The growing season here is comparatively short, the temperature much lower than is general throughout the Eastern states, but nature comes to the rescue and forces ahead the plants so that they mature more quickly. This is quite marked among the native flora—the plants casting off their seeds under a shorter and shorter growing period until as we

near the snow line we find as the snow melts plants spring up and apparently within a few days bloom and seed, so that it is a no uncommon sight to see plants flowering within a few feet of the receding snow.

Aside from the changes which may be produced in the growing plant by altitude and arid conditions, the hay made from the plant will be desiccated to a greater extent, which would tend to make the hay more brittle and, therefore, more easily masticated than hay from the same plant cured under more humid conditions.

The digestion experiments have been confined almost exclusively to alfalfa hay and were conducted with sheep. The fourth experiment was with some native hay, but a duplicate was not obtained, as one of the subjects broke the pen, making his escape and for a few hours carried on the experiment to his liking. The sheep (two) were Rambouillet grades, about two years of age, obtained from the range near the station. The results given here were with the same two sheep which will be indicated by K and KK, respectively.

Second growth alfalfa was used in all of the experiments. It was well cured and apparently a fair sample of second growth alfalfa as produced upon the Laramie Plains. Alfalfa for experiments I and II was grown on the experiment farm near Laramie, which had been irrigated during the growing season with water from the Pioneer Canal. The alfalfa for experiment III was from the farm of Mr. Arnold, also under the Pioneer Canal.

The alfalfa for use in every experiment was chopped with a small hand feed cutter directly into manila sacks, each holding a little more than a pound. For experiment I samples of about one-fourth pound were taken from every fifth sack; for experiment II samples were taken from each sack; and for experiment III samples were taken between each sack. Composite samples for each experiment were made from these, except in experiment II, where four composite samples were

made, Nos. 1 and 2 being the analysis of samples of the feed during the preliminary feeding for each sheep, and Nos. 3 and 4 the analysis of samples of feed fed during the experiment proper. This was done to note the variation in the composition, and also to test the method of sampling. The average is taken as the composition of the fodder.

In experiment No. I the feces voided each day was analyzed separately to note the variation in composition; no distinctive variation was noticed. The first day in this experiment the sacks were put on the sheep in the morning and emptied at night, while the last day represents about thirty-six hours, which accounts for the variation in weights of the feces upon these respective days.

(In the following tables the term "Fat" is used for "Ether Extract," "Fiber" for "Crude Fiber," "Protein" for "Crude Protein," and "Extract" for "Nitrogen-free Extract.")

EXPERIMENT I—ALFALFA.

SHEEP K.

Weight of fodder fed and consumed in five days, 3,400.0 grams.

ANALYSIS OF FODDER.

Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
5.38	10.28	1.46	29.35	17.32	36.21

FODDER CONSTITUENTS FED AND CONSUMED, IN GRAMS.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
3,201.8	349.7	49.6	998.0	588.8	1,215.7

FECES.

Weight of air dried feces—	First day	184.9 grams
	Second day	237.4 grams
	Third day	230.8 grams
	Fourth day	236.2 grams
	Fifth day	317.7 grams

ANALYSIS OF FECES.

	Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
First day	2.00	11.73	2.67	46.73	9.13	27.74
Second day	1.61	12.50	2.72	44.48	9.38	29.31
Third day	1.73	12.63	2.68	44.48	9.51	28.97
Fourth day	2.01	11.79	2.67	45.89	9.13	28.51
Fifth day	2.28	12.55	2.63	44.62	9.38	28.54

FODDER CONSTITUENTS VOIDED, GRAMS.

	Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
First day	181.2	21.7	4.9	86.4	16.9	51.3
Second day	233.6	29.7	6.4	105.6	22.3	69.6
Third day	226.8	29.1	6.2	102.6	22.0	66.9
Fourth day	231.5	27.8	6.3	108.4	21.6	67.4
Fifth day	310.5	39.9	8.3	141.8	29.8	90.7
Total	1,183.6	148.2	32.1	544.8	112.6	345.9
*Less 2/122	19.4	2.4	0.5	8.9	1.9	5.7
	1,164.2	145.8	31.6	535.9	110.7	340.2

*Two hours overrun.

FODDER CONSTITUENTS DIGESTED.

	Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
Consumed	3,201.8	349.7	49.6	998.0	588.8	1,215.7
Voided	1,164.2	145.8	31.6	535.9	110.7	340.2
Digested	2,037.6	203.9	18.0	462.1	478.1	875.5
Per cent digested	63.64	58.31	36.29	46.30	81.20	72.02

SHEEP KK.

Weight of fodder consumed and composition same as for Sheep K.

FECES.

Weight air dry feces—	First day	167.8 grams
	Second day	244.3 grams
	Third day	198.3 grams
	Fourth day	248.8 grams
	Fifth day	360.2 grams

ANALYSIS OF FECES.

	Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
First day	2.77	11.85	2.59	44.80	9.38	28.61
Second day	2.48	12.77	2.73	43.83	9.44	28.75
Third day	2.10	13.79	3.00	43.72	9.63	27.76
Fourth day	2.72	13.58	2.67	43.95	9.38	27.70
Fifth day	2.58	13.61	2.71	43.35	9.63	28.12

FODDER CONSTITUENTS VOIDED, GRAMS.

	Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
First day	163.2	19.9	4.4	75.2	15.7	48.0
Second day	238.2	31.2	6.7	107.0	23.1	70.2
Third day	194.2	27.4	5.9	86.7	19.1	55.1
Fourth day	242.0	33.8	6.6	109.4	23.3	68.9
Fifth day	350.9	49.0	9.8	156.1	34.7	101.3
Total	1,188.5	161.3	33.4	534.4	115.9	343.5
*Less 2/122	19.5	2.6	0.6	8.8	1.9	5.6
	1,169.0	158.7	32.8	525.6	114.0	337.9

*Two hours overrun.

FODDER CONSTITUENTS DIGESTED.

	Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
Consumed	3,201.8	349.7	49.6	998.0	588.8	1,215.7
Voided	1,169.0	158.7	32.8	525.6	114.0	337.9
Digested	2,032.8	191.0	16.8	472.4	474.8	877.8
Per cent digested	63.49	54.62	33.87	47.33	80.64	72.23

Average Co-efficients (Two Sheep), Experiment I.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
63.57	56.47	35.03	46.82	80.92	72.12

EXPERIMENT II—ALFALFA.

SHEEP K.

Weight of fodder fed and consumed in five days, 4,535.0 grams.

ANALYSES OF FODDER.

	Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
First	6.45	7.91	1.44	34.99	13.13	36.08
Second	5.50	7.88	1.51	33.71	14.06	37.34
Third	6.46	8.50	1.56	31.13	15.13	37.22
Fourth	6.60	8.17	1.42	33.06	14.06	36.69
Average	6.25	8.12	1.48	33.22	14.10	36.83

FODDER CONSTITUENTS FED AND CONSUMED, IN GRAMS.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
4,251.6	368.2	67.2	1,506.8	639.4	1,670.0

FECES.

Weight air dry............1,782.0 grams

ANALYSIS OF FECES.

Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
4.98	9.22	1.97	49.90	7.88	26.05

FODDER CONSTITUENTS VOIDED, GRAMS.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
1,693.3	164.3	35.0	889.3	140.4	464.3

FODDER CONSTITUENTS DIGESTED.

	Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
Consumed	4,251.6	368.2	67.2	1,506.8	639.4	1,670.0
Voided	1,693.3	164.3	35.0	889.3	140.4	464.3
Digested	2,558.3	203.9	32.2	617.5	499.0	1,205.7
Per cent digested	60.17	55.38	47.92	40.98	78.04	72.20

SHEEP KK.

Weight of fodder consumed and composition same as for Sheep K.

FECES.

Weight of air dry feces....1,795.0 grams

ANALYSIS OF FECES.

Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
4.79	9.40	2.03	49.90	8.19	25.69

FODDER CONSTITUENTS VOIDED, GRAMS.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
1,709.0	168.7	36.4	895.7	147.0	461.2

FODDER CONSTITUENTS DIGESTED.

	Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
Consumed	4,251.6	368.2	67.2	1,506.8	639.4	1,670.0
Voided	1,709.0	168.7	36.4	895.7	147.0	461.2
Digested	2,542.6	199.5	30.8	611.1	492.4	1,208.8
Per cent digested	59.80	54.18	45.83	40.56	77.01	72.38

Average Co-efficients (Two Sheep), Experiment II.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
59.99	**54.78**	**46.88**	**40.77**	**77.53**	**72.29**

EXPERIMENT III—ALFALFA.

SHEEP K.

Weight of fodder fed and consumed in five days, 4,535.0 grams.

ANALYSIS OF FODDER.

Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
6.70	8.87	1.69	27.36	15.88	39.50

FODDER CONSTITUENTS FED AND CONSUMED, IN GRAMS.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
4,231.2	402.4	76.6	1,240.6	720.1	1,791.5

FECES.

Weight air dry feces......1,489.0 grams

ANALYSIS OF FECES.

Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
4.98	12.06	3.12	43.74	9.38	26.72

FODDER CONSTITUENTS VOIDED, GRAMS.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
1,414.9	179.5	46.4	651.3	139.7	398.0

FODDER CONSTITUENTS DIGESTED.

	Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
Consumed	4,231.2	402.4	76.6	1,240.6	720.1	1,791.5
Voided	1,414.9	179.5	46.4	651.3	139.7	398.0
Digested	2,816.3	222.9	30.2	589.3	580.4	1,393.5
Per cent digested	66.56	55.39	39.43	47.50	80.60	77.78

SHEEP KK.

Weight of fodder consumed and its composition same as for Sheep K.

FECES.

Weight of air dry feces....1,486.0 grams

ANALYSIS OF FECES.

Moisture.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
5.11	11.07	2.89	44.79	9.44	26.70

FODDER CONSTITUENTS VOIDED, GRAMS.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
1,410.1	164.5	43.0	665.6	140.3	396.7

FODDER CONSTITUENTS DIGESTED.

	Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
Consumed	4,231.2	402.4	76.6	1,240.6	720.1	1,791.5
Voided	1,410.1	164.5	43.0	665.6	140.3	396.7
Digested	2,821.1	327.9	33.6	575.0	579.8	1,394.8
Per cent digested	66.67	59.12	43.86	46.35	80.52	77.86

Average Co-efficients (Two Sheep), Experiment III.

Dry Matter.	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
66.62	**57.25**	**41.65**	**46.93**	**80.56**	**77.82**

SUMMARY—CO-EFFICIENTS.

Digestion Exp't.	*Dry Matter.*	*Ash.*	*Fat.*	*Fiber.*	*Protein.*	*Extract.*
No. 1, Sheep K	63.64	58.31	36.29	46.30	81.20	72.02
No. 1, Sheep KK	63.49	54.62	33.87	47.33	80.64	72.21
No. 2, Sheep K	60.17	55.38	47.92	40.98	78.04	72.20
No. 2, Sheep KK	59.80	54.18	45.83	40.56	77.01	72.38
No. 3, Sheep K	66.56	55.39	39.43	47.50	80.60	77.78
No. 3, Sheep KK	66.67	59.12	43.86	46.35	80.52	77.86
Maximum	66.67	59.12	47.92	47.50	81.20	77.86
Minimum	59.80	54.18	33.87	40.56	77.01	72.02
Average (six)	**63.39**	**56.17**	**41.20**	**44.84**	**79.67**	**74.08**

It would hardly be wise to make general statements in comparing with Eastern Alfalfa, considering the small amount of data thus far obtained, but the results are concordant and it appears that the second growth alfalfa grown under our conditions is more digestible than first growth alfalfa grown and cured at low altitudes under humid conditions.

III. ALKALI STUDIES.—These studies are the continuation of the work on alkali which has been carried on at this station for a number of years past. It has been suggested that the selective absorption of salts from solutions by seeds and growing plants, without apparent regard to concentration of the different salts, is due in a measure at least to the difference in the ionic velocities, and that the process cannot be considered altogether a physiological one, but rather chemical and physical. Potassium, for example, has a relative migration velocity of 59.7 compared to 41.1 for sodium (in N./1000 solution), which may account for potassium being taken up by plants in preference to sodium, regardless of their original proportions in the solution.

We know that the diffusibility of a salt is different when mixed with other salts from what it is when alone. When two salts are in solution together, the more rapid is accelerated and the slower is retarded both absolutely and relatively.*

*Oswald: Lehrbuch der Allg. Chemie, I, 695.

In the experiments which are at present being carried on it is the endeavor to determine what effect the addition of ions of different velocities have upon the absorption of different salts, by seeds, from solutions of the same osmotic pressure.

The investigations are still in progress and the results are not as yet ready for publication. It is the intention to carry on this work during the following year.

HENRY G. KNIGHT, Chemist.

TABLES FOR USE IN NITROGEN AND PROTEIN DETERMINATIONS.

FRANK E. HEPNER, ASSISTANT STATION CHEMIST.

The following tables are published here in the hope that they may be useful to others who are working with the Kjeldahl or the Gunning method of nitrogen determination. They are being used in this laboratory and are found to be the means of saving considerable time in the calculation of results.

Table I is adapted from a similar one published by Vivian,* but has been recalculated on the basis of 14.04 for the atomic weight of nitrogen. For greater accuracy the results are carried to three places.

The figures at the top of the table under the heading "C. C. of ½ Normal Acid" represent the number of c. c. of ½ normal acid placed in the receiver before distilling, and the numbers in the column headed "C. C. 1/10 N. Alkali" represent the number of c. c. of 1/10 normal alkali used in titrating back the excess of acid after distilling.

To use the table, first calculate the nitrogen in the reagents, as found by blank determinations, to its equivalent in c. c. of 1/10 normal alkali and add the result to the number of c. c. used in titrating back. Find this sum in the column headed "C. C. 1/10 N. Alkali," then to the right in the proper column will be found the per cent of nitrogen.

*Seventeenth Annual Report, Wis. Expt. Station.

EXAMPLE.—One gram of substance was used for analysis. 5 c. c. of ½ normal acid were placed in the receiver. After distillation it required 2.60 c. c. of 1/10 normal alkali to neutralize the excess of acid. By blank determinations it was found that the nitrogen in the reagents equaled 0.15 c. c. of 1/10 normal alkali. $2.60 + 0.15 = 2.75$ c. c. of 1/10 normal alkali. By looking up 2.75 in the column headed "C..C. 1/10 N. Alkali" and following the line to the right until the column headed "5" is reached, there will be found 3.124, the per cent of nitrogen sought.

If the amount of 1/10 normal alkali required is 5 c. c. or more, divide the number of c. c. used by 5, take the remainder as the number of c. c. of alkali used, subtract the quotient from the number of c. c. of ½ normal acid placed in the receiver and proceed as before.

EXAMPLE.—One gram of substance was used. 9 c. c. of ½ normal acid were placed in the receiver and 11.30 c. c. of 1/10 alkali were required to neutralize the excess acid. Correction for reagents $= 0.15$ c. c. alkali. $11.30 + 0.15 = 11.45$. $11.45 \div 5 = 2$, with a remainder of 1.45. $9 - 2 = 7$. By using 1.45 c. c. as the amount of alkali required and 7 c. c. as the amount of acid used, and applying the table as before, there will be found 4.710 as the per cent of nitrogen sought.

If more than 10 c. cc. of ½ normal acid are required, find the per cent of nitrogen given in the table under the unit figure of the number used and to this add 7.02 per cent for each ten in the number of c. c. used.

EXAMPLE.—12 c. c. of ½ normal acid were used and 0.80 c. c. of 1/10 normal alkali required to neutralize the excess of acid, no correction for reagents being necessary. The number under 0.80 c. c. alkali and 2 c. c. acid is 1.292. $1.292 + 7.02 = 8.312$ per cent nitrogen in the sample.

If more than one gram of substance is used for analysis, the table may still be used by proceeding as follows: Find the number in the table just as though only one gram had been

used. This divided by the weight of the sample taken gives the per cent of nitrogen.

EXAMPLE.—2.3671 grams of substance were taken for analysis. 9 c. c. of ½ normal acid were used and 1.10 c. c. of 1/10 normal alkali were required to neutralize the excess acid. The number found in the table under 9 c. c. acid and 1.10 c. c. alkali is 6.164. Then 6.164 ÷ 2.3671 = 2.604 = per cent nitrogen.

Some prefer to use 1/5 normal acid instead of ½ normal. Table II has, therefore, been prepared and is here presented. The method of using it is the same as for table I, except in the case where the amount of 1/10 normal alkali required exceeds the limits of the table, then the number of c. c. alkali used must be divided by 2 (instead of 5), and the remainder and quotient used as in that table.

Table III is for converting per cent nitrogen into per cent crude protein (N. × 6.25). The first column gives the per cent and tenths per cent of nitrogen, the corresponding per cent of crude protein being found in the next column. For added hundredths per cent of nitrogen, use the corresponding column to the right.

EXAMPLE.—Given 3.4 per cent of nitrogen; how much crude protein (N. × 6.25) would there be? *Ans.:* 21.25 per cent. With 3.47 per cent nitrogen, how much protein? *Ans.:* 21.69.

Table IV is the same as table I, except that the results are per cents of crude protein (N. × 6.25). The idea of expressing the results in crude protein was obtained from some excellent conversion tables published by McDonnell*, among which is a table giving the per cent of crude protein directly from the amount of 1/10 normal acid neutralized during distillation. Table IV, however, gives the per cent of crude protein direct from the amount of 1/10 normal alkali used in titrating back the excess of acid and thereby saves some computation.

*Md. Agr'l College Quarterly: May, 1904, Supplement.

TABLE I.—Per cent of Nitrogen corresponding to any titration where ½ normal acid and 1/10 normal alkali are used. Calculated for one gram substance.

NOTE.—The minus sign (—) following a number indicates that the last place is less than five and therefore should not be added to the preceding when only two places are used.

C. C. 1/10 N. Alkali.	C. C. of ½ Normal Acid.									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0.00.........	0.702	1.404	2.106	2.808	3.510	4.212	4.914	5.616	6.318	7.020
0.05.........	0.695—	1.397	2.099	2.801	3.503	4.205—	4.907	5.609	6.311	7.013
0.10.........	0.688	1.390	2.092	2.794	3.496	4.198	4.900	5.602	6.304	7.006
0.15.........	0.681	1.383	2.085—	2.787	3.489	4.191	4.893	5.595—	6.297	6.999
0.20.........	0.674	1.376	2.078	2.780	3.482	4.184	4.886	5.588	6.290	6.992
0.25.........	0.667	1.369	2.071	2.773	3.475—	4.177	4.879	5.581	6.283	6.985—
0.30.........	0.660	1.362	2.064	2.766	3.468	4.170	4.872	5.574	6.276	6.978
0.35.........	0.653	1.355—	2.057	2.759	3.461	4.163	4.865—	5.567	6.269	6.971
0.40.........	0.646	1.348	2.050	2.752	3.454	4.156	4.858	5.560	6.262	6.964
0.45.........	0.639	1.341	2.043	2.745—	3.447	4.149	4.851	5.553	6.255—	6.957
0.50.........	0.632	1.334	2.036	2.738	3.440	4.142	4.844	5.546	6.248	6.950
0.55.........	0.625—	1.327	2.029	2.731	3.433	4.135—	4.837	5.539	6.241	6.943
0.60.........	0.618	1.320	2.022	2.724	3.426	4.128	4.830	5.532	6.234	6.936
0.65.........	0.611	1.313	2.015—	2.717	3.419	4.121	4.823	5.525—	6.227	6.929
0.70.........	0.604	1.306	2.008	2.710	3.412	4.114	4.816	5.518	6.220	6.922
0.75.........	0.597	1.299	2.001	2.703	3.405—	4.107	4.809	5.511	6.213	6.915—
0.80.........	0.590	1.292	1.994	2.696	3.398	4.100	4.802	5.504	6.206	6.908
0.85.........	0.583	1.285—	1.987	2.689	3.391	4.093	4.795—	5.497	6.199	6.901
0.90.........	0.576	1.278	1.980	2.682	3.384	4.086	4.788	5.490	6.192	6.894
0.95.........	0.569	1.271	1.973	2.675—	3.377	4.079	4.781	5.483	6.185—	6.887
1.00.........	0.562	1.264	1.966	2.668	3.370	4.072	4.774	5.476	6.178	6.880
1.05.........	0.555—	1.257	1.959	2.661	3.363	4.065—	4.767	5.469	6.171	6.873
1.10.........	0.548	1.250	1.952	2.654	3.356	4.058	4.760	5.462	6.164	6.866
1.15.........	0.541	1.243	1.945—	2.647	3.349	4.051	4.753	5.455—	6.157	6.859
1.20.........	0.534	1.236	1.938	2.640	3.342	4.044	4.746	5.448	6.150	6.852
1.25.........	0.527	1.229	1.931	2.633	3.335—	4.037	4.739	5.441	6.143	6.845—
1.30.........	0.519	1.221	1.923	2.625	3.327	4.029	4.731	5.433	6.135	6.837
1.35.........	0.512	1.214	1.916	2.618	3.320	4.022	4.724	5.426	6.128	6.830
1.40.........	0.505	1.207	1.909	2.611	3.313	4.015	4.717	5.419	6.121	6.823
1.45.........	0.498	1.200	1.902	2.604	3.306	4.008	4.710	5.412	6.114	6.816
1.50.........	0.491	1.193	1.895	2.597	3.299	4.001	4.703	5.405	6.107	6.809
1.55.........	0.484	1.186	1.888	2.590	3.292	3.994	4.696	5.398	6.100	6.802
1.60.........	0.477	1.179	1.881	2.583	3.285	3.987	4.689	5.391	6.093	6.795
1.65.........	0.470	1.172	1.874	2.576	3.278	3.980	4.682	5.384	6.086	6.788
1.70.........	0.463	1.165	1.867	2.569	3.271	3.973	4.675	5.377	6.079	6.781
1.75.........	0.456	1.158	1.860	2.562	3.264	3.966	4.668	5.370	6.072	6.774
1.80.........	0.449	1.151	1.853	2.555	3.257	3.959	4.661	5.363	6.065	6.767
1.85.........	0.442	1.144	1.846	2.548	3.250	3.952	4.654	5.356	6.058	6.760
1.90.........	0.435	1.137	1.839	2.541	3.243	3.945	4.647	5.349	6.051	6.753
1.95.........	0.428	1.130	1.832	2.534	3.236	3.938	4.640	5.342	6.044	6.746
2.00.........	0.421	1.123	1.825	2.527	3.229	3.931	4.633	5.335	6.037	6.739
2.05.........	0.414	1.116	1.818	2.520	3.222	3.924	4.626	5.328	6.030	6.732
2.10.........	0.407	1.109	1.811	2.513	3.215	3.917	4.619	5.321	6.023	6.725
2.15.........	0.400	1.102	1.804	2.506	3.208	3.910	4.612	5.314	6.016	6.718
2.20.........	0.393	1.095	1.797	2.499	3.201	3.903	4.605	5.307	6.009	6.711
2.25.........	0.386	1.088	1.790	2.492	3.194	3.896	4.598	5.300	6.002	6.704
2.30.........	0.379	1.081	1.783	2.485	3.187	3.889	4.591	5.293	5.995	6.697
2.35.........	0.372	1.074	1.776	2.478	3.180	3.882	4.584	5.286	5.988	6.690
2.40.........	0.365	1.067	1.769	2.471	3.173	3.875	4.577	5.279	5.981	6.683
2.45.........	0.358	1.060	1.762	2.464	3.166	3.868	4.570	5.272	5.974	6.676
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

TABLE I.—Continued.

C. C. 1/10 N. Alkali.	C. C. of ½ Normal Acid.									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2.50.........	0.351	1.053	1.755	2.457	3.159	3.861	4.563	5.265	5.967	6.669
2.55.........	0.344	1.046	1.748	2.450	3.152	3.854	4.556	5.258	5.960	6.662
2.60.........	0.337	1.039	1.741	2.443	3.145—	3.847	4.549	5.251	5.953	6.655—
2.65.........	0.330	1.032	1.734	2.436	3.138	3.840	4.542	5.244	5.946	6.648
2.70.........	0.323	1.025—	1.727	2.429	3.131	3.833	4.535—	5.237	5.939	6.641
2.75.........	0.316	1.018	1.720	2.422	3.124	3.826	4.528	5.230	5.932	6.634
2.80.........	0.309	1.011	1.713	2.415—	3.117	3.819	4.521	5.223	5.925—	6.627
2.85.........	0.302	1.004	1.706	2.408	3.110	3.812	4.514	5.216	5.918	6.620
2.90.........	0.295—	0.997	1.699	2.401	3.103	3.805—	4.507	5.209	5.911	6.613
2.95.........	0.288	0.990	1.692	2.394	3.096	3.798	4.500	5.202	5.904	6.606
3.00.........	0.281	0.983	1.685—	2.387	3.089	3.791	4.493	5.195—	5.897	6.599
3.05.........	0.274	0.976	1.678	2.380	3.082	3.784	4.486	5.188	5.890	6.592
3.10.........	0.267	0.969	1.671	2.373	3.075—	3.777	4.479	5.181	5.883	6.585—
3.15.........	0.260	0.962	1.664	2.366	3.068	3.770	4.472	5.174	5.876	6.578
3.20.........	0.253	0.955—	1.657	2.359	3.061	3.763	4.465—	5.167	5.869	6.571
3.25.........	0.246	0.948	1.650	2.352	3.054	3.756	4.458	5.160	5.862	6.564
3.30.........	0.239	0.941	1.643	2.345—	3.047	3.749	4.451	5.153	5.855—	6.557
3.35.........	0.232	0.934	1.636	2.338	3.040	3.742	4.444	5.146	5.848	6.550
3.40.........	0.225—	0.927	1.629	2.331	3.033	3.735—	4.437	5.139	5.841	6.543
3.45.........	0.218	0.920	1.622	2.324	3.026	3.728	4.430	5.132	5.834	6.536
3.50.........	0.211	0.913	1.615—	2.317	3.019	3.721	4.423	5.125—	5.827	6.529
3.55.........	0.204	0.906	1.608	2.310	3.012	3.714	4.416	5.118	5.820	6.522
3.60.........	0.197	0.899	1.601	2.303	3.005—	3.707	4.409	5.111	5.813	6.515—
3.65.........	0.190	0.892	1.594	2.296	2.998	3.700	4.402	5.104	5.806	6.508
3.70.........	0.183	0.885—	1.587	2.289	2.991	3.693	4.395—	5.097	5.799	6.501
3.75.........	0.176	0.878	1.580	2.282	2.984	3.686	4.388	5.090	5.792	6.494
3.80.........	0.168	0.870	1.572	2.274	2.976	3.678	4.380	5.082	5.784	6.486
3.85.........	0.161	0.863	1.565	2.267	2.969	3.671	4.373	5.075	5.777	6.479
3.90.........	0.154	0.856	1.558	2.260	2.962	3.664	4.366	5.068	5.770	6.472
3.95.........	0.147	0.849	1.551	2.253	2.955	3.657	4.359	5.061	5.763	6.465
4.00.........	0.140	0.842	1.544	2.246	2.948	3.650	4.352	5.054	5.756	6.458
4.05.........	0.133	0.835	1.537	2.239	2.941	3.643	4.345	5.047	5.749	6.451
4.10.........	0.126	0.828	1.530	2.232	2.934	3.636	4.338	5.040	5.742	6.444
4.15.........	0.119	0.821	1.523	2.225	2.927	3.629	4.331	5.033	5.735	6.437
4.20.........	0.112	0.814	1.516	2.218	2.920	3.622	4.324	5.026	5.728	6.430
4.25.........	0.105	0.807	1.509	2.211	2.913	3.615	4.317	5.019	5.721	6.423
4.30.........	0.098	0.800	1.502	2.204	2.906	3.608	4.310	5.012	5.714	6.416
4.35.........	0.091	0.793	1.495	2.197	2.899	3.601	4.303	5.005	5.707	6.409
4.40.........	0.084	0.786	1.488	2.190	2.892	3.594	4.296	4.998	5.700	6.402
4.45.........	0.077	0.779	1.481	2.183	2.885	3.587	4.289	4.991	5.693	6.395
4.50.........	0.070	0.772	1.474	2.176	2.878	3.580	4.282	4.984	5.686	6.388
4.55.........	0.063	0.765	1.467	2.169	2.871	3.573	4.275	4.977	5.679	6.381
4.60.........	0.056	0.758	1.460	2.162	2.864	3.566	4.268	4.970	5.672	6.374
4.65.........	0.049	0.751	1.453	2.155	2.857	3.559	4.261	4.963	5.665	6.367
4.70.........	0.042	0.744	1.446	2.148	2.850	3.552	4.254	4.956	5.658	6.360
4.75.........	0.035	0.737	1.439	2.141	2.843	3.545	4.247	4.949	5.651	6.353
4.80.........	0.028	0.730	1.432	2.134	2.836	3.538	4.240	4.942	5.644	6.346
4.85.........	0.021	0.723	1.425	2.127	2.829	3.531	4.233	4.935	5.637	6 339
4.90.........	0.014	0.716	1.418	2.120	2.822	3.524	4.226	4.928	5.630	6.332
4.95.........	0.007	0.709	1.411	2.113	2.815	3.517	4.219	4.921	5.623	6.325
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

TABLE II.—Per cent of nitrogen corresponding to any titration where 1/5 normal acid and 1/10 normal alkali are used. Calculated for one gram substance.

C. C. 1/10 N. Alkali.	C. C. of 1/5 Normal Acid.											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
0.00	0.28	0.56	0.84	1.12	1.40	1.68	1.97	2.25	2.53	2.81	3.09	3.37
0.05	0.27	0.55	0.84	1.12	1.40	1.68	1.96	2.24	2.52	2.80	3.08	3.36
0.10	0.27	0.55	0.83	1.11	1.39	1.67	1.95	2.23	2.51	2.79	3.07	3.36
0.15	0.26	0.54	0.82	1.10	1.38	1.66	1.94	2.23	2.51	2.79	3.07	3.35
0.20	0.25	0.53	0.81	1.10	1.38	1.66	1.94	2.22	2.50	2.78	3.06	3.34
0.25	0.25	0.53	0.81	1.09	1.37	1.65	1.93	2.21	2.49	2.77	3.05	3.33
0.30	0.24	0.52	0.80	1.08	1.36	1.64	1.92	2.20	2.49	2.77	3.05	3.33
0.35	0.23	0.51	0.79	1.07	1.35	1.64	1.92	2.20	2.48	2.76	3.04	3.32
0.40	0.22	0.51	0.79	1.07	1.35	1.63	1.91	2.19	2.47	2.75	3.03	3.31
0.45	0.22	0.50	0.78	1.06	1.34	1.62	1.90	2.18	2.46	2.74	3.03	3.31
0.50	0.21	0.49	0.77	1.05	1.33	1.61	1.90	2.18	2.46	2.74	3.02	3.30
0.55	0.20	0.48	0.77	1.05	1.33	1.61	1.89	2.17	2.45	2.73	3.01	3.29
0.60	0.20	0.48	0.76	1.04	1.32	1.60	1.88	2.16	2.44	2.72	3.00	3.29
0.65	0.19	0.47	0.75	1.03	1.31	1.59	1.87	2.16	2.44	2.72	3.00	3.28
0.70	0.18	0.46	0.74	1.02	1.31	1.59	1.87	2.15	2.43	2.71	2.99	3.27
0.75	0.18	0.46	0.74	1.02	1.30	1.58	1.86	2.14	2.42	2.70	2.98	3.26
0.80	0.17	0.45	0.73	1.01	1.29	1.57	1.85	2.13	2.41	2.70	2.98	3.26
0.85	0.16	0.44	0.72	1.00	1.28	1.57	1.85	2.13	2.41	2.69	2.97	3.25
0.90	0.15	0.44	0.72	1.00	1.28	1.56	1.84	2.12	2.40	2.68	2.96	3.24
0.95	0.15	0.43	0.71	0.99	1.27	1.55	1.83	2.11	2.39	2.67	2.96	3.24
1.00	0.14	0.42	0.70	0.98	1.26	1.54	1.83	2.11	2.39	2.67	2.95	3.23
1.05	0.13	0.41	0.69	0.98	1.26	1.54	1.82	2.10	2.38	2.66	2.94	3.22
1.10	0.13	0.41	0.69	0.97	1.25	1.53	1.81	2.09	2.37	2.65	2.93	3.22
1.15	0.12	0.40	0.68	0.96	1.24	1.52	1.80	2.08	2.37	2.65	2.93	3.21
1.20	0.11	0.39	0.67	0.95	1.24	1.52	1.80	2.08	2.36	2.64	2.92	3.20
1.25	0.11	0.39	0.67	0.95	1.23	1.51	1.79	2.07	2.35	2.63	2.91	3.19
1.30	0.10	0.38	0.66	0.94	1.22	1.50	1.78	2.06	2.34	2.63	2.91	3.19
1.35	0.09	0.37	0.65	0.93	1.21	1.50	1.78	2.06	2.34	2.62	2.90	3.18
1.40	0.08	0.37	0.65	0.93	1.21	1.49	1.77	2.05	2.33	2.61	2.89	3.17
1.45	0.08	0.36	0.64	0.92	1.20	1.48	1.76	2.04	2.32	2.60	2.89	3.17
1.50	0.07	0.35	0.63	0.91	1.19	1.47	1.76	2.04	2.32	2.60	2.88	3.16
1.55	0.06	0.34	0.62	0.91	1.19	1.47	1.75	2.03	2.31	2.59	2.87	3.15
1.60	0.06	0.34	0.62	0.90	1.18	1.46	1.74	2.02	2.30	2.58	2.86	3.14
1.65	0.05	0.33	0.61	0.89	1.17	1.45	1.73	2.01	2.30	2.58	2.86	3.14
1.70	0.04	0.32	0.60	0.88	1.17	1.45	1.73	2.01	2.29	2.57	2.85	3.13
1.75	0.04	0.32	0.60	0.88	1.16	1.44	1.72	2.00	2.28	2.56	2.84	3.12
1.80	0.03	0.31	0.59	0.87	1.15	1.43	1.71	1.99	2.27	2.56	2.84	3.12
1.85	0.02	0.30	0.58	0.86	1.14	1.43	1.71	1.99	2.27	2.55	2.83	3.11
1.90	0.01	0.29	0.58	0.86	1.14	1.42	1.70	1.98	2.26	2.54	2.82	3.10
1.95	0.01	0.29	0.57	0.85	1.13	1.41	1.69	1.97	2.25	2.53	2.82	3.10
2.00	0.00	0.28	0.56	0.84	1.12	1.40	1.68	1.97	2.25	2.53	2.81	3.09
2.05	....	0.27	0.55	0.84	1.12	1.40	1.68	1.96	2.24	2.52	2.80	3.08
2.10	....	0.27	0.55	0.83	1.11	1.39	1.67	1.95	2.23	2.51	2.79	3.07
2.15	....	0.26	0.54	0.82	1.10	1.38	1.66	1.94	2.23	2.51	2.79	3.07
2.20	....	0.25	0.53	0.81	1.10	1.38	1.66	1.94	2.22	2.50	2.78	2.06
2.25	....	0.25	0.53	0.81	1.09	1.37	1.65	1.93	2.21	2.49	2.77	3.05
2.30	....	0.24	0.52	0.80	1.08	1.36	1.64	1.92	2.20	2.49	2.77	3.05
2.35	....	0.23	0.51	0.79	1.07	1.35	1.64	1.92	2.20	2.48	2.76	3.04
2.40	....	0.22	0.51	0.79	1.07	1.35	1.63	1.91	2.19	2.47	2.75	3.03
2.45	....	0.22	0.50	0.78	1.06	1.34	1.62	1.90	2.18	2.46	2.74	3.03
2.50	....	0.21	0.49	0.77	1.05	1.33	1.61	1.90	2.18	2.46	2.74	3.02
2.55	....	0.20	0.48	0.77	1.05	1.33	1.61	1.89	2.17	2.45	2.73	3.01
2.60	....	0.20	0.48	0.76	1.04	1.32	1.60	1.88	2.16	2.44	2.72	3.00
2.65	....	0.19	0.47	0.75	1.03	1.31	1.59	1.87	2.16	2.44	2.72	3.00
2.70	....	0.18	0.46	0.74	1.02	1.31	1.59	1.87	2.15	2.43	2.71	2.99
2.75	....	0.18	0.46	0.74	1.02	1.30	1.58	1.86	2.14	2.42	2.70	2.98
2.80	....	0.17	0.45	0.73	1.01	1.29	1.57	1.85	2.13	2.41	2.70	2.98
2.85	....	0.16	0.44	0.72	1.00	1.28	1.57	1.85	2.13	2.41	2.69	2.97
2.90	....	0.15	0.44	0.72	1.00	1.28	1.56	1.84	2.12	2.40	2.68	2.96
2.95	....	0.15	0.43	0.71	0.99	1.27	1.55	1.83	2.11	2.39	2.67	2.96
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

TABLE II.—Continued.

1/10 N. Alkali.	C. C. of 1/5 Normal Acid.												
	13	14	15	16	17	18	19	20	21	22	23	24	25
0.00	3.65	3.93	4.21	4.49	4.77	5.05	5.34	5.62	5.90	6.18	6.46	6.74	7.02
0.05	3.64	3.92	4 21	4.49	4.77	5.05	5.33	5.61	5.89	6.17	6.45	6.73	7.01
0.10	3.64	3.92	4.20	4.48	4.76	5.04	5.32	5.60	5.88	6.16	6.44	6.73	7.01
0.15	3.63	3.91	4.19	4.47	4.75	5.03	5.31	5.60	5.88	6.16	6.44	6.72	7.00
0.20	3.62	3.90	4.18	4.46	4.75	5.03	5.31	5.59	5.87	6.15	6.43	6.71	6.99
0.25	3.62	3.90	4.18	4.46	4.74	5.02	5.30	5.58	5.86	6.14	6.42	6.70	6.98
0.30	3.61	3.89	4.17	4.45	4.73	5.01	5.29	5.57	5.85	6.14	6.42	6.70	6.98
0.35	3.60	3.88	4.16	4.44	4.72	5.01	5.29	5.57	5.85	6.13	6.41	6.69	6.97
0.40	3.59	3.88	4.16	4.44	4.72	5.00	5.28	5.56	5.84	6.12	6.40	6.68	6.96
0.45	3.59	3.87	4.15	4.43	4.71	4.99	5.27	5.55	5.83	6.11	6.40	6.68	6.96
0.50	3.58	3.86	4.14	4.42	4.70	4.98	5.27	5.55	5.83	6.11	6.39	6.67	6.95
0.55	3.57	3.85	4.13	4.42	4.70	4.98	5.26	5.54	5.82	6.10	6.38	6.66	6.94
0.60	3.57	3.85	4.13	4.41	4.69	4.97	5.25	5.53	5.81	6.09	6.37	6.65	6.94
0.65	3.56	3.84	4.12	4.40	4.68	4.96	5.24	5.52	5.81	6.09	6.37	6.65	6.93
0.70	3.55	3.83	4.11	4.39	4.68	4.96	5.24	5.52	5.80	6.08	6.36	6.64	6.92
0.75	3.55	3.83	4.11	4.39	4.67	4.95	5.23	5.51	5.79	6.07	6.35	6.63	6.91
0.80	3.54	3.82	4.10	4.38	4.66	4.94	5.22	5.50	5.78	6.07	6.35	6.63	6.91
0.85	3.53	3.81	4.09	4.37	4.65	4.94	5.22	5.50	5.78	6.06	6.34	6.62	6.90
0.90	3.52	3.80	4.09	4.37	4.65	4.93	5.21	5.49	5.77	6.05	6.33	6.61	6.89
0.95	3.52	3.80	4.08	4.36	4.64	4.92	5.20	5.48	5.76	6.04	6.33	6.61	6.89
1.00	3.51	3.79	4.07	4.35	4.63	4.91	5.19	5.48	5.76	6.04	6.32	6.60	6.88
1.05	3.50	3.78	4.06	4.35	4.63	4.91	5.19	4.47	5.75	6.03	6.31	6.59	6.87
1.10	3.50	3.78	4.06	4.34	4.62	4.90	5.18	5.46	5.74	6.02	6.30	6.58	6.87
1.15	3.49	3.77	4.05	4.33	4.61	4.89	5.17	5.45	5.74	6.02	6.30	6.58	6.86
1.20	3.48	3.76	4.04	4.32	4.61	4.89	5.17	5.45	5.73	6.01	6.29	6.57	6.85
1.25	3.47	3.76	4.04	4.32	4.60	4.88	5.16	5.44	5.72	6.00	6.28	6.56	6.84
1.30	3.47	3.75	4.03	4.31	4.59	4.87	5.15	5.43	5.71	6.00	6.28	6.56	6.84
1.35	3.46	3.74	4.02	4.30	4.58	4.86	5.15	5.43	5.71	5.99	6.27	6.55	6.83
1.40	3.45	3.73	4.02	4.30	4.58	4.86	5.14	5.42	5.70	5.98	6.26	6.54	6.82
1.45	3.45	3.73	4.01	4.29	4.57	4.85	5.13	5.41	5.69	5.97	6.25	6.54	6.82
1.50	3.44	3.72	4.00	4.28	4.56	4.84	5.12	5.41	5.69	5.97	6.25	6.53	6.81
1.55	3.43	3.71	3.99	4.28	4.56	4.84	5.12	5.40	5.68	5.96	6.24	6.52	6.80
1.60	3.43	3.71	3.99	4.27	4.55	4.83	5.11	5.39	5.67	5.95	6.23	6.51	6.80
1.65	3.42	3.70	3.98	4.26	4.54	4.82	5.10	5.38	5.67	5.95	6.23	6.51	6.79
1.70	3.41	3.69	3.97	4.25	4.53	4.82	5.10	5.38	5.66	5.94	6.22	6.50	6.78
1.75	3.40	3.69	3.97	4.25	4.53	4.81	5.09	5.37	5.65	5.93	6.21	6.49	6.77
1.80	3.40	3.68	3.96	4.24	4.52	4.80	5.08	5.36	5.64	5.92	6.21	6.49	6.77
1.85	3.39	3.67	3.95	4.23	4.51	4.79	5.08	5.36	5.64	5.92	6.20	6.48	6.76
1.90	3.38	3.66	3.95	4.23	4.51	4.79	5.07	5.35	5.63	5.91	6.19	6.47	6.75
1.95	3.38	3.66	3.94	4.22	4.50	4.78	5.06	5.34	5.62	5.90	6.18	6.47	6.75
2.00	3.37	3.65	3.93	4.21	4.49	4.77	5.05	5.34	5.62	5.90	6.18	6.46	6.74
2.05	3.36	3.64	3.92	4.21	4.49	4.77	5.05	5.33	5.61	5.89	6.17	6.45	6.73
2.10	3.36	3.64	3.92	4.20	4.48	4.76	5.04	5.32	5.60	5.88	6.16	6.44	6.73
2.15	3.35	3.63	3.91	4.19	4.47	4.75	5.03	5.31	5.60	5.88	6.16	6.44	6.72
2.20	3.34	3.62	3.90	4.18	4.46	4.75	5.03	5.31	5.59	5.87	6.15	6.43	6.71
2.25	3.33	3.62	3.90	4.18	4.46	4.74	5.02	5.30	5.58	5.86	6.14	6.42	6.70
2.30	3.33	3.61	3.89	4.17	4.45	4.73	5.01	5.29	5.57	5.85	6.14	6.42	6.70
2.35	3.32	3.60	3.88	4.16	4.44	4.72	5.01	5.29	5.57	5.85	6.13	6.41	6.69
2.40	3.31	3.59	3.88	4.16	4.44	4.72	5.00	5.28	5.56	5.84	6.12	6.40	6.68
2.45	3.31	3.59	3.87	4.15	4.43	4.71	4.99	5.27	5.55	5.83	6.11	6.40	6.68
2.50	3.30	3.58	3.86	4.14	4.42	4.70	4.98	5.27	5.55	5.83	6.11	6.39	6.67
2.55	3.29	3.57	3.85	4.13	4.42	4.70	4.98	5.26	5.54	5.82	6.10	6.38	6.66
2.60	3.29	3.57	3.85	4.13	4.41	4.69	4.97	5.25	5.53	5.81	6.09	6.37	6.65
2.65	3.28	3.56	3.84	4.12	4.40	4.68	4.96	5.24	5.52	5.81	6.09	6.37	6.65
2.70	3.27	3.55	3.83	4.11	4.39	4.68	4.96	5.24	5.52	5.80	6.08	6.36	6.64
2.75	3.26	3.55	3.83	4.11	4.39	4.67	4.95	5.23	5.51	5.79	6.07	6.35	6.63
2.80	3.26	3.54	3.82	4.10	4.38	4.66	4.94	5.22	5.50	5.78	6.07	6.35	6.63
2.85	3.25	3.53	3.81	4.09	4.37	4.65	4.94	5.22	5.50	5.78	6.06	6.34	6.62
2.90	3.24	3.52	3.80	4.09	4.37	4.65	4.93	5.21	5.49	5.77	6.05	6.33	6.61
2.95	3.24	3.52	3.80	4.08	4.36	4.64	4.92	5.20	5.48	5.76	6.04	6.33	6.61
	13	14	15	16	17	18	19	20	21	22	23	24	25

TABLE III.—Conversion of nitrogen into crude protein (N x 6.25).

Nitrogen.	0	1	2	3	4	5	6	7	8	9
0.0	0.00	0.06	0.13	0.19	0.25	0.31	0.38	0.44	0.50	0.56
0.1	0.63	0.69	0.75	0.81	0.88	0.94	1.00	1.06	1.13	1.19
0.2	1.25	1.31	1.38	1.44	1.50	1.56	1.63	1.69	1.75	1.81
0.3	1.88	1.94	2.00	2.06	2.13	2.19	2.25	2.31	2.38	2:44
0.4	2.50	2.56	2.63	2.69	2.75	2.81	2.88	2.94	3.00	3.06
0.5	3.13	3.19	3.25	3.31	3.38	3.44	3.50	3.56	3.63	3.69
0.6	3.75	3.81	3.88	3.94	4.00	4.06	4.13	4.19	4.25	4.31
0.7	4.38	4.44	4.50	4.56	4.63	4.69	4.75	4.81	4.88	4.94
0.8	5.00	5.06	5.13	5.19	5.25	5.31	5.38	5.44	5.50	5.56
0.9	5.63	5.69	5.75	5.81	5.88	5.94	6.00	6.06	6.13	6.19
1.0	6.25	6.31	6.38	6.44	6.50	6.56	6.63	6.69	6.75	6.81
1.1	6.88	6.94	7.00	7.06	7.13	7.19	7.25	7.31	7.38	7.44
1.2	7.50	7.56	7.63	7.69	7.75	7.81	7.88	7.94	8.00	8.06
1.3	8.13	8.19	8.25	8.31	8.38	8.44	8.50	8.56	8.63	8.69
1.4	8.75	8.81	8.88	8.94	9.00	9.06	9.13	9.19	9.25	9.31
1.5	9.38	9.44	9.50	9.56	9.63	9.69	9.75	9.81	9.88	9.94
1.6	10.00	10.06	10.13	10.19	10.25	10.31	10.38	10.44	10.50	10.56
1.7	10.63	10.69	10.75	10.81	10.88	10.94	11.00	11.06	11.13	11.19
1.8	11.25	11.31	11.38	11.44	11.50	11.56	11.63	11.69	11.75	11.81
1.9	11.88	11.94	12.00	12.06	12.13	12.19	12.25	12.31	12.38	12.44
2.0	12.50	12.56	12.63	12.69	12.75	12.81	12.88	12.94	13.00	13.06
2.1	13.13	13.19	13.25	13.31	13.38	13.44	13.50	13.56	13.63	13.69
2.2	13.75	13.81	13.88	13.94	14.00	14.06	14.13	14.19	14.25	14.31
2.3	14.38	14.44	14.50	14.56	14.63	14:69	14.75	14.81	14.88	14.94
2.4	15.00	15.06	15.13	15.19	15.25	15.31	15.38	15.44	15.50	15.56
2.5	15.63	15.69	15.75	15.81	15.88	15.94	16.00	16.06	16.13	16.19
2.6	16.25	16.31	16.38	16.44	16.50	16.56	16.63	16.69	16.75	16.81
2.7	16.88	16.94	17.00	17.06	17.13	17.19	17.25	17.31	17.38	17.44
2.8	17.50	17.56	17.63	17.69	17.75	17.81	17.88	17.94	18.00	18.06
2.9	18.13	18.19	18.25	18.31	18.38	18.44	18.50	18.56	18.63	18.69
3.0	18.75	18.81	18.88	18.94	19.00	19.06	19.13	19.19	19.25	19.31
3.1	19.38	19.44	19.50	19.56	19.63	19.69	19.75	19.81	19.88	19.94
3.2	20.00	20.06	20.13	20.19	20.25	20.31	20.38	20.44	20.50	20.56
3.3	20.63	20.69	20.75	20.81	20.88	20.94	21.00	21.06	21.13	21.19
3.4	21.25	21.31	21.38	21.44	21.50	21.56	21.63	21.69	21.75	21.81
3.5	21.88	21.94	22.00	22.06	22.13	22.19	22.25	22.31	22.38	22.44
3.6	22.50	22.56	22.63	22.69	22.75	22.81	22.88	22.94	23.00	23.06
3.7	23.13	23.19	23.25	23.31	23.38	23.44	23.50	23.56	23.63	23.69
3.8	23.75	23.81	23.88	23.94	24.00	24.06	24.13	24.19	24.25	24.31
3.9	24.38	24.44	24.50	24.56	24.63	24.69	24.75	24.81	24.88	24.94
4.0	25.00	25.06	25.13	25.19	25.25	25.31	25.38	25.44	25.50	25.56
4.1	25.63	25.69	25.75	25.81	25.88	25.94	26.00	26.06	26.13	26.19
4.2	26.25	26.31	26.38	26.44	26.50	26.56	26.63	26.69	26.75	26.81
4.3	26.88	26.94	27.00	27.06	27.13	27.19	27.25	27.31	27.38	27.44
4.4	27.50	27.56	27.63	27.69	27.75	27.81	27.88	27.94	28.00	28.06
4.5	28.13	28.19	28.25	28.31	28.38	28.44	28.50	28.56	28.63	28.69
4.6	28.75	28.81	28.88	28.94	29.00	29.06	29.13	29.19	29.25	29.31
4.7	29.38	29.44	29.50	29.56	29.63	29.69	29.75	29.81	29.88	29.94
4.8	30.00	30.06	30.13	30.19	30.25	30.31	30.38	30.44	30.50	30.56
4.9	30.63	30.69	30.75	30.81	30.88	30.94	31.00	31.06	31.13	31.19
	0	1	2	3	4	5	6	7	8	9

TABLE III.—Continued.

Nitrogen.	0	1	2	3	4	5	6	7	8	9
5.0	31.25	31.31	31.38	31.44	31.50	31.56	31.63	31.69	31.75	31.81
5.1	31.88	31.94	32.00	32.06	32.13	32.19	32.25	32.31	32.38	32 44
5.2	32.50	32.56	32.63	32.69	32.75	32.81	32.88	32.94	33.00	33.06
5.3	33.13	33.19	33.25	33.31	33.38	33.44	33.50	33.56	33.63	33.69
5.4	33.75	33.81	33.88	33.94	34.00	34.06	34.13	34.19	34.25	34.31
5.5	34.38	34.44	34.50	34.56	34.63	34.69	34.75	34.81	34.88	34.94
5.6	35.00	35.06	35.13	35.19	35.25	35.31	35.38	35.44	35.50	35.56
5.7	35.63	35.69	35.75	35.81	35.88	35.94	36.00	36.06	36.13	36.19
5.8	36.25	36.31	36.38	36.44	36.50	36.56	36.63	36.69	36.75	36.81
5.9	36.88	36.94	37.00	37.06	37.13	37.19	37.25	37.31	37.38	37.44
6.0	37.50	37.56	37.63	37.69	37.75	37.81	37.88	37.94	38.00	38.06
6.1	38.13	38.19	38.25	38.31	38.38	38.44	38.50	38.56	38.63	38.69
6.2	38.75	38.81	38.88	38.94	39.00	39.06	39.13	39.19	39.25	39.31
6.3	39.38	39.44	39.50	39.56	39.63	39.69	39.75	39.81	39.88	39.94
6.4	40.00	40.06	40.13	40.19	40.25	40.31	40.38	40.44	40.50	40.56
6.5	40.63	40.69	40.75	40.81	40.88	40.94	41.00	41.06	41.13	41.19
6.6	41.25	41.31	41.38	41.44	41.50	41.56	41.63	41.69	41.75	41.81
6.7	41.88	41.94	42.00	42.06	42.13	42.19	42.25	42.31	42.38	42.44
6.8	42.50	42.56	42.63	42.69	42.75	42.81	42.88	42.94	43.00	43.06
6.9	43.13	43.19	43.25	43.31	43.38	43.44	43.50	43.56	43.63	43.69
7.0	43.75	43.81	43.88	43.94	44.00	44.06	44.13	44.19	44.25	44.31
7.1	44.38	44.44	44.50	44.56	44.63	44.69	44.75	44.81	44.88	44.94
7.2	45.00	45.06	45.13	45.19	45.25	45.31	45.38	45.44	45.50	45.56
7.3	45.63	45.69	45.75	45.81	45.88	45.94	46.00	46.06	46.13	46.19
7.4	46.25	46.31	46.38	46.44	46.50	46.56	46.63	46.69	46.75	46.81
7.5	46.88	46.94	47.00	47.06	47.13	47.19	47.25	47.31	47.38	47.44
7.6	47.50	47.56	47.63	47.69	47.75	47.81	47.88	47.94	48.00	48.06
7.7	48.13	48.19	48.25	48.31	48.38	48.44	48.50	48.56	48.63	48.69
7.8	48.75	48.81	48.88	48.94	49.00	49.06	49.13	49.19	49.25	49.31
7.9	49.38	49.44	49.50	49.56	49.63	49.69	49.75	49.81	49.88	49.94
8.0	50.00	50.06	50.13	50.19	50.25	50.31	50.38	50.44	50.50	50.56
8.1	50.63	50.69	50.75	50.81	50.88	50.94	51.00	51.06	51.13	51.19
8.2	51.25	51.31	51.38	51.44	51.50	51.56	51.63	51.69	51.75	51.81
8.3	51.88	51.94	52.00	52.06	52.13	52.19	52.25	52.31	52.38	52.44
8.4	52.50	52.56	52.63	52.69	52.75	52.81	52.88	52.94	53.00	53.06
8.5	53.13	53.19	53.25	53.31	53.38	53.44	53.50	53.56	53.63	53.69
8.6	53.75	53.81	53.88	53.94	54.00	54.06	54.13	54.19	54.25	54.31
8.7	54.38	54.44	54.50	54.56	54.63	54.69	54.75	54.81	54.88	54.94
8.8	55.00	55.06	55.13	55.19	55.25	55.31	55.38	55.44	55.50	55.56
8.9	55.63	55.69	55.75	55.81	55.88	55.94	56.00	56.06	56.13	56.19
9.0	56.25	56.31	56.38	56.44	56.50	56.56	56.63	56.69	56.75	56.81
9.1	56.88	56.94	57.00	57.06	57.13	57.19	57.25	57.31	57.38	57.44
9.2	57.50	57.56	57.63	57.69	57.75	57.81	57.88	57.94	58.00	58.06
9.3	58.13	58.19	58.25	58.31	58.38	58.44	58.50	58.56	58.63	58.69
9.4	58.75	58.81	58.88	58.94	59.00	59.06	59.13	59.19	59.25	59.31
9.5	59.38	59.44	59.50	59.56	59.63	59.69	59.75	59.81	59.88	59.94
9.6	60.00	60.06	60.13	60.19	60.25	60.31	60.38	60.44	60.50	60.56
9.7	60.63	60.69	60.75	60.81	60.88	60.94	61.00	61.06	61.13	61.19
9.8	61.25	61.31	61.38	61.44	61.50	61.56	61.63	61.69	61.75	61.81
9.9	61.88	61.94	62.00	62.06	62.13	62.19	62.25	62.31	62.38	62.44
	0	1	2	3	4	5	6	7	8	9

TABLE IV.—Per cent of crude protein corresponding to any titration where ½ normal acid and 1/10 normal alkali are used. Calculated for one gram substance.

C. C. 1/10 N. Alkali.	C. C. of ½ Normal Acid.									
	1	2	3	4	5	6	7	8	9	10
0.00	4.39	8.78	13.16	17.55	21.94	26.32	30.71	35.10	39.49	43.88
0.05	4.34	8.73	13.12	17.51	21.89	26.28	30.67	35.06	39.44	43.83
0.10	4.30	8.69	13.08	17.46	21.85	26.24	30.63	35.01	39.40	43.79
0.15	4.26	8.64	13.03	17.42	21.81	26.19	30.58	34.97	39.36	43.74
0.20	4.21	8.60	12.99	17.38	21.76	26.15	30.54	34.92	39.31	43.70
0.25	4.17	8.56	12.94	17.33	21.72	26.11	30.49	34.88	39.27	43.66
0.30	4.12	8.51	12.90	17.29	21.67	26.06	30.45	34.84	39.22	43.61
0.35	4.08	8.47	12.86	17.24	21.63	26.02	30.41	34.79	39.18	43.57
0.40	4.04	8.42	12.81	17.20	21.59	25.97	30.36	34.75	39.14	43.52
0.45	3.99	8.38	12.77	17.16	21.54	25.93	30.32	34.71	39.09	43.48
0.50	3.95	8.34	12.72	17.11	21.50	25.89	30.27	34.66	39.05	43.44
0.55	3.91	8.29	12.68	17.07	21.46	25.84	30.23	34.62	39.00	43.39
0.60	3.86	8.25	12.64	17.02	21.41	25.80	30.19	34.57	38.96	43.35
0.65	3.82	8.21	12.59	16.98	21.37	25.75	30.14	34.53	38.92	43.30
0.70	3.77	8.16	12.55	16.94	21.32	25.71	30.10	34.49	38.87	43.26
0.75	3.73	8.12	12.51	16.89	21.28	25.67	30.06	34.44	38.83	43.22
0.80	3.69	8.07	12.46	16.85	21.24	25.62	30.01	34.40	38.79	43.17
0.85	3.64	8.03	12.42	16.80	21.19	25.58	29.97	34.35	38.74	43.13
0.90	3.60	7.99	12.37	16.76	21.15	25.54	29.92	34.31	38.70	43.09
0.95	3.56	7.94	12.33	16.72	21.10	25.49	29.88	34.27	38.65	43.04
1.00	3.51	7.90	12.29	16.67	21.06	25.45	29.84	34.22	38.61	43.00
1.05	3.47	7.86	12.24	16.63	21.02	25.40	29.79	34.18	38.57	42.95
1.10	3.42	7.81	12.20	16.58	20.97	25.36	29.75	34.14	38.52	42.91
1.15	3.38	7.77	12.15	16.54	20.93	25.32	29.70	34.09	38.48	42.87
1.20	3.33	7.72	12.11	16.50	20.88	25.27	29.66	34.05	38.44	42.82
1.25	3.29	7.68	12.07	16.45	20.84	25.23	29.62	34.00	38.39	42.78
1.30	3.25	7.63	12.02	16.41	20.80	25.18	29.57	33.96	38.35	42.73
1.35	3.20	7.59	11.98	16.37	20.75	25.14	29.53	33.92	38.30	42.69
1.40	3.16	7.55	11.93	16.32	20.71	25.10	29.48	33.87	38.26	42.65
1.45	3.12	7.50	11.89	16.28	20.67	25.05	29.44	33.83	38.22	42.60
1.50	3.07	7.46	11.85	16.23	20.62	25.01	28.40	33.78	38.17	42.56
1.55	3.03	7.41	11.80	16.19	20.58	24.96	29.35	33.74	38.13	42.51
1.60	2.98	7.37	11.76	16.15	20.53	24.92	29.31	33.70	38.08	42.47
1.65	2.94	7.33	11.71	16.10	20.49	24.88	29.26	33.65	38.04	42.43
1.70	2.90	7.28	11.67	16.06	20.45	24.83	29.22	33.61	38.00	42.38
1.75	2.85	7.24	11.63	16.01	20.40	24.79	29.18	33.56	37.95	42.34
1.80	2.81	7.20	11.58	15.97	20.36	24.75	29.13	33.52	37.91	42.30
1.85	2.76	7.15	11.54	15.93	20.31	24.70	29.09	33.48	37.86	42.25
1.90	2.72	7.11	11.50	15.88	20.27	24.66	29.05	33.43	37.82	42.21
1.95	2.68	7.06	11.45	15.84	20.23	24.61	29.00	33.39	37.78	12.16
2.00	2.63	7.02	11.41	15.80	20.18	24.57	28.96	33.35	37.73	42.12
2.05	2.59	6.98	11.36	15.75	20.14	24.53	28.91	33.30	37.69	42.08
2.10	2.54	6.93	11.32	15.71	20.09	24.48	28.87	33.26	37.64	42.03
2.15	2.50	6.89	11.28	15.66	20.05	24.44	28.82	33.21	37.60	41.99
2.20	2.46	6.84	11.23	15.62	20.01	24.39	28.78	33.17	37.56	41.94
2.25	2.41	6.80	11.19	15.58	19.96	24.35	28.74	33.13	37.51	41.90
2.30	2.37	6.76	11.14	15.53	19.92	24.31	28.69	33.08	37.47	41.86
2.35	2.33	6.71	11.10	15.49	19.88	24.26	28.65	33.04	37.43	41.81
2.40	2.28	6.67	11.06	15.44	19.83	24.22	28.61	32.99	37.38	41.77
2.45	2.24	6.63	11.01	15.40	19.79	24.18	28.56	32.95	37.34	41.73
	1	2	3	4	5	6	7	8	9	10

TABLE IV.—Continued.

C. C. 1/10 N. Alkali.	C. C. of ½ Normal Acid.									
	1	2	3	4	5	6	7	8	9	10
2.50	2.19	6.58	10.97	15.36	19.74	24.13	28.52	32.91	37.29	41.68
2.55	2.15	6.54	10.92	15.31	19.70	24.09	28.47	32.86	37.25	41.64
2.60	2.11	6.49	10.88	15.27	19.66	24.04	28.43	32.82	37.21	41.59
2.65	2.06	6.45	10.84	15.22	19.61	24.00	28.39	32.77	37.16	41.55
2.70	2.02	6.41	10.79	15.18	19.57	23.96	28.34	32.73	37.12	41.51
2.75	1.97	6.36	10.75	15.14	19.52	23.91	28.30	32.69	37.07	41.46
2.80	1.93	6.32	10.71	15.09	19.48	23.87	28.26	32.64	37.03	41.42
2.85	1.89	6.27	10.66	15.05	19.44	23.82	28.21	32.60	36.99	41.37
2.90	1.84	6.23	10.62	15.01	19.39	23.78	28.17	32.56	36.94	41.33
2.95	1.80	6.19	10.57	14.96	19.35	23.74	28.12	32.51	36.90	41.29
3.00	1.76	6.14	10.53	14.92	19.31	23.69	28.08	32.47	36.86	41.24
3.05	1.71	6.10	10.49	14.87	19.26	23.65	28.04	32.42	36.81	41.20
3.10	1.67	6.05	10.44	14.83	19.22	23.60	27.99	32.38	36.77	41.15
3.15	1.62	6.01	10.40	14.79	19.17	23.56	27.95	32.34	36.72	41.11
3.20	1.58	5.97	10.35	14.74	19.13	23.52	27.90	32.29	36.68	41.07
3.25	1.54	5.92	10.31	14.70	19.09	23.47	27.86	32.25	36.64	41.02
3.30	1.49	5.88	10.27	14.65	19.04	23.43	27.82	32.20	36.59	40.98
3.35	1.45	5.84	10.22	14.61	19.00	23.39	27.77	32.16	36.55	40.94
3.40	1.40	5.79	10.18	14.57	18.95	23.34	27.73	32.12	36.50	40.89
3.45	1.36	5.75	10.14	14.52	18.91	23.30	27.69	32.07	36.46	40.85
3.50	1.32	5.70	10.09	14.48	18.87	23.25	27.64	32.03	36.42	40.80
3.55	1.27	5.66	10.05	14.43	18.82	23.21	27.60	31.98	36.37	40.76
3.60	1.23	5.62	10.00	14.39	18.78	23.17	27.55	31.94	36.33	40.72
3.65	1.18	5.57	9.96	14.35	18.73	23.12	27.51	31.90	36.28	40.67
3.70	1.14	5.53	9.92	14.30	18.69	23.08	27.47	31.85	36.24	40.63
3.75	1.10	5.48	9.87	14.26	18.65	23.03	27.42	31.81	36.20	40.58
3.80	1.05	5.44	9.83	14.22	18.60	22.99	27.38	31.77	36.15	40.54
3.85	1.01	5.40	9.78	14.17	18.56	22.95	27.33	31.72	36.11	40.50
3.90	0.97	5.35	9.74	14.13	18.52	22.90	27.29	31.68	36.07	40.45
3.95	0.92	5.31	9.70	14.08	18.47	22.86	27.25	31.63	36.02	40.41
4.00	0.88	5.27	9.65	14.04	18.43	22.82	27.20	31.59	35.98	40.37
4.05	0.83	5.22	9.61	14.00	18.38	22.77	27.16	31.55	35.93	40.32
4.10	0.79	5.18	9.56	13.95	18.34	22.73	27.11	31.50	35.89	40.28
4.15	0.75	5.13	9.52	13.91	18.30	22.68	27.07	31.46	35.85	40.23
4.20	0.70	5.09	9.48	13.86	18.25	22.64	27.03	31.41	35.80	40.19
4.25	0.66	5.05	9.43	13.82	18.21	22.60	26.98	31.37	35.76	40.15
4.30	0.61	5.00	9.39	13.78	18.16	22.55	26.94	31.33	35.71	40.10
4.35	0.57	4.96	9.35	13.73	18.12	22.51	26.90	31.28	35.67	40.06
4.40	0.53	4.91	9.30	13.69	18.08	22.46	26.85	31.24	35.63	40.01
4.45	0.48	4.87	9.26	13.65	18.03	22.42	26.81	31.20	35.58	39.97
4.50	0.44	4.83	9.21	13.60	17.99	22.38	26.76	31.15	35.54	39.93
4.55	0.39	4.78	9.17	13.56	17.94	22.33	26.72	31.11	35.49	39.88
4.60	0.35	4.74	9.13	13.51	17.90	22.29	26.68	31.06	35.45	39.84
4.65	0.31	4.69	9.08	13.47	17.86	22.24	26.63	31.02	35.41	39.79
4.70	0.26	4.65	9.04	13.43	17.81	22.20	26.59	30.98	35.36	39.75
4.75	0.22	4.61	8.99	13.38	17.77	22.16	26.54	30.93	35.32	39.71
4.80	0.18	4.56	8.95	13.34	17.73	22.11	26.50	30.89	35.28	39.66
4.85	0.13	4.52	8.91	13.29	17.68	22.07	26.46	30.84	35.23	39.62
4.90	0.09	4.48	8.86	13.25	17.64	22.03	26.41	30.80	35.19	39.58
4.95	0.04	4.43	8.82	13.21	17.59	21.98	26.37	30.76	35.14	39.53
	1	2	3	4	5	6	7	8	9	10

Report of the Botanist.

The time available for station work to one who holds also a chair in the college (in this case including three subjects—botany, zoology, and physiology) is necessarily very limited. Research problems requiring uninterrupted attention or a prolonged series of observations are practically barred under such conditions. Particularly is this true in investigations which require field work involving repeated observations. It is doubly true if the work that needs to be done is in remote portions of the state, which, for want of time and because of the great cost of travel, can scarcely be visited even once in each season. There are several problems of importance that call for study by the Botanist, but these need to be studied on the ground where the problems occur. The fruit growing sections have theirs which cannot be solved by a quadrennial, biennial, or even an annual visit. The diversified farming of the lower altitudes in the state is attended by the usual troubles that are found in similar localities in other states. Satisfactory help and information even to such, at long range, is scarcely possible. It is to be hoped that soon it may seem feasible to secure an assistant to do much of the teaching, in order that the Botanist of the station may devote his best energy to research work along lines of vital importance to the plant industry in the state.

A large portion of the relatively small amount of available time has been occupied by routine work. A surprisingly and increasingly large number of inquiries reach the office. These vary from a mere inquiry as to the name of some plant (or animal) submitted, to requests for full statements relative to their actual and relative merits. Information concerning suitable crops for particular localities and soils is frequently sought. Fungus and insect diseases elicit many inquiries. All

letters are answered, and, in so far as is possible, remedies are suggested and formulæ supplied.

In co-operation with the Chemical Department, the introduction and all the descriptions, technical and popular, were prepared for Bulletin 65 (Wyoming Forage Plants—Their Chemical Composition).

Nearly a week in September of 1904 was spent at the State Industrial Convention (State Fair) at Casper, in charge of the judging of the agricultural and horticultural exhibits.

A paper was prepared for the first annual meeting of the State Wool Growers' Association, which met at Cheyenne in April. The title of the paper, which was published in full in the May issue of *The American Shepherd's Bulletin,* was "The Improvement of the Range."

In April some lectures were given at the first Farmers' Short Course ever held by the station men outside of Laramie. The large number of the people of Big Horn County who assembled at Cody for this three days' institute was very gratifying, indeed.

A few short articles and items have been contributed to various publications, and one or two technical papers on the flora of the state have appeared.

Some of the subjects mentioned in the outline of work in the last report are in such a state of preparation as to permit of publication whenever it shall be deemed wise by the station.

Outline Plans.

OUTLINE PLANS, DIRECTOR AND PROFESSOR OF AGRICULTURE, 1905-1906.

I. Agronomy—

(a) General Crops—Wheat, Barley, and Oats, Flax, etc., for seed and feed.

(b) Field Pease.

(c) Forage Crops—Alfalfa, Grasses, etc. Studies with White Sweet Clover. Ranch Studies.

(d) The Nitrogen Problem. Laboratory Experiments. Greenhouse.

(e) Management of Soils. Reclamation Co-operation.

II. Animal Industry—

(a) Ration Experiments with Cattle, Sheep, and Swine.

(b) Digestion Experiments in Co-operation with Chemist.

(c) Breeding Experiments with Cattle, Horses, Sheep, Swine, and Guinea Pigs.

(d) Poultry Experiments. Production for Market. Wool Investigations.

(e) Scouring Wool and Study of Wool Fibre.

(f) Gathering Data and Photographs of the Stock Industry as Found in the State.

III. Horticulture—

(a) Notes on Fruits.

(b) Vegetables—Garden.

(c) New Fruit Experiments at Lander.

IV. Irrigation—
- (1) Irrigation Practice—
  - (a) Duty of Water.
  - (b) Amount of Water to Produce Maximum Crops.
- (2) Reclamation—Drainage.
- (3) Co-operation with Dry Farming—Office of Experiment Stations.

V. Miscellaneous—
- (a) Publications—Regular Bulletins, Press Bulletins, Monthly Ranchman's Reminder, Articles for Agricultural Press, Articles for Local Papers, and Annual Report.
- (b) Records and Photographs.
- (c) Farmers' Institutes and Short Courses.
- (d) Agricultural Propaganda. Correspondence.

PLANS OF WORK, CHEMIST, 1905-1906.

I. Digestion Experiments in Co-operation with Department of Agriculture.
II. Forage Plant Analyses.
III. Studies of Seepage Water.
IV. Alkali Studies.

Meteorological Summary.

Highest temperature, 83 degrees, July 12 and 15.
Lowest temperature, ~~−42~~ 26 degrees, ~~February 13~~. Jan. 28
Mean temperature for year, 41.9 degrees.
Greatest daily range, 49 degrees, August 22.
Lowest daily range, 6 degrees, January 30.
Highest barometer, 23.355, September 3.
Lowest barometer, 22.465, March 20.
Mean barometer, 23.024.
Prevailing direction wind, west.
Greatest velocity per hour, 60 miles, February 1, 22, 23, March 2, and May 19.
Greatest number miles in one hour, 54, February 1.
Greatest number miles in one day, 886, February 23.
Greatest number miles in one month, 12,726, February.
Least number miles in one month, 6,460, November.
Average monthly distance, 9,492.
Average daily distance, 311.
Average hourly distance, 13.
Total number miles for year, 113,901.
Number of clear days, 219.
Number of partly cloudy days, 121.
Number of cloudy days, 36.
Number on which .01 inch or more precipitation fell, 78.
Greatest precipitation in one storm, .68 inch, September 29.
Highest monthly precipitation, 2.01 inch, June.
Lowest monthly precipitation, .04 inch, November.
Total precipitation, 9.58 inches.
Mean precipitation past ten years, 9.80 inches.
Evaporation, 1.866 feet (May 7-September 15).
Greatest monthly evaporation, .518 foot, July.

PRECIPITATION FOR PAST FOURTEEN YEARS, INCHES.

1891	13.92	1896	10.75	1901	8.52
1892	12.73	1897	11.99	1902	7.65
1893	3.84	1898	7.63	1903	10.33
1894	7.63	1899	11.84	1904	9.58
1895	11.15	1900	8.53		

THE UNIVERSITY OF WYOMING

AGRICULTURAL COLLEGE DEPARTMENT

SIXTEENTH ANNUAL REPORT

. . . OF THE . . .

U. S. Agricultural Experiment Station

. . . OF . . .

WYOMING

1905-1906

LARAMIE, WYOMING,
U. S. A.

WYOMING
Agricultural Experiment Station

UNIVERSITY OF WYOMING.

STATION STAFF.

F. M. Tisdel, Ph. D............................President
B. C. Buffum, M. S..........Director, Agriculturist and Horticulturist
A. Nelson, M. S., Ph. D............................Botanist
H. G. Knight, A. M............................Chemist
C. B. Ridgaway, A. M....................Physicist and Meteorologist
G. R. Hebard, A. M., Ph. D............................Secretary
G. E. Morton, M. L., B. S......................Animal Husbandman
F. E. Hepner, B. S............................Research Chemist
E. L. Case............................Stenographer

Letter of Transmittal.

U. S. Agricultural Experiment Station,
University of Wyoming.

To His Excellency, Bryant B. Brooks, Governor of Wyoming.

Sir:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating Agricultural Experiment Stations, I have the honor herewith to submit the Sixteenth Annual Report of the U. S. Agricultural Experiment Station of Wyoming, for the fiscal year ending June 30, 1906.

B. C. Buffum

Director.

University of Wyoming, June 30, 1906.

Table of Contents.

Report of the Station Staff.

Report of the Director.

Origin and Purpose of the Station.—The Wyoming Experiment Station has received the benefit of the Hatch appropriation for sixteen years, and there have been published fifteen annual reports preceding the present one. These several reports contain a general account of the station and the work of each year. They have not been so widely distributed as the station bulletins, and the following paragraph of history and purpose is repeated:

Briefly, the purpose of the station is *research* in agriculture, and the publishing of such bulletins and reports as will enable our people to put to practical use the results of this research. The fact that this expenditure and work is primarily for the benefit of the people of Wyoming does not seem to be so generally understood as it should be. Many do not realize the purport of the fact that the most progressive nations are generously fostering both the theoretical and practical education of those engaged in every agricultural industry. In our own country the two Morrill acts establishing and supporting our Agricultural and Mechanical Colleges provide for the foundation education of our youth, and the Hatch act of 1887 makes an appropriation by Congress of $15,000 annually to each state and territory for scientific research in agriculture and the dissemination of the results of such investigations to the people through agricultural bulletins, which are sent free upon request for them. Some experimental work was done in Wyoming as early as 1889, and on January 10, 1891, the Legislature author-

ized the University of Wyoming to receive an appropriation by Congress for the establishment of an Experiment Station. The work of the station was organized and a Station Staff was elected in March and April of 1891. The results of the station work, and executive details up to the beginning of the last fiscal year, are published in the fifteen annual reports and the sixty-six regular station bulletins which have been issued.

THE PRESENT ORGANIZATION OF THE STATION.—The Experiment Station is administered by the Board of Trustees of the University of Wyoming. The general affairs in the interim of the semi-annual meetings of the board are placed in the charge of the Agricultural Executive Committee. This committee consists of three resident members of the Board of Trustees. Action may also be taken by the Executive Committee of the board, which has power to make appointments, to fill vacancies, and to audit the bills of the station. The President of the University is also President of the Agricultural College, and as such is advisory member and chairman of the Station Council. The Station Council is made up of several investigators employed to do the station work. The President of the University is chairman, and the Secretary of the Board of Trustees is the secretary of the council. The Director is the executive head of the Experiment Station, in direct charge of the work and expenditures carried on under the Hatch and also the new Adams act, account of which will be found in this report.

The Station Council meets from time to time at the call of the Director to pass upon and organize plans for the work in the several departments, and adopts all bulletin material for publication, recommending it to the Agricultural Executive Committee, which takes official action in ordering the various publications which have been adopted. The subject material and composition of bulletins written by members of the Station Staff and others are openly discussed and criticised, and accepted for publication or referred back to the writer for re-

vision. The writer of a bulletin may select two other members of the Station Staff to aid him in reading proof.

CHANGES IN THE STATION STAFF.—The personnel of the Station Staff remains the same as it did at the beginning of the last fiscal year, with two exceptions. Mr. G. E. Morton, M. L., B. S., was promoted to an associate professorship, and had full charge of his department through the year.

Mr. Herbert T. Nowell, B. S., was appointed instructor in Irrigation Engineering, Surveying, and Drafting in the University, and also made a member of the Station Staff. His time during the year was very largely taken up in instruction, and but a very small part of his salary was paid from the Experiment Station fund.

THE ADAMS FUND.

Up to the present fiscal year the Experiment Station has had no increase in funds with which to carry on its work since it was first organized. Some indirect help has been extended through purchase of buildings for station use from the state fund, and the supplementary publication of *The Ranchman's Reminder* has been paid for out of funds other than those from the general government.

The act known as the Adams Bill passed Congress and was approved by the President on March 16, 1906. This bill provided an increase in the money set aside for investigation of $5,000 for the fiscal year ending June 30, 1906. An adverse opinion of the Comptroller of the Treasury threatened to postpone the provisions of the act for the year, but a rider was attached to the general agricultural appropriation bill defining the time when the Adams money should be available and setting aside the $5,000 for each station for this fiscal year, making the appropriation for the next fiscal year of $7,000, to increase by $2,000 each year until it reaches $15,000. The agricultural appropriation bill passed Congress on June

28th, and we were notified on the 29th that the money would be available. However, it took until the afternoon of June 30th to get information that the whole appropriation was available, and it was necessary to contract for the total expenditures within the fiscal year in order that it should be received. This was not a difficult matter, however, for we had been prepared for the passage of the bill both by the officials of the Office of Experiment Stations and by Senator Warren, and had made provisional arrangements for the expenditure of the money. These arrangements set aside $2,200 for the purchase of breeding sheep, $1,500 for the purchase of lambs with which to conduct feeding experiments, $800 for equipment in the Department of Chemistry, and $1,000 for dry farm equipment. Telegrams and letters were sent at once ordering the material which had been before selected. The plan of work which should cover investigations under the Adams fund had been submitted to the Office of Experiment Stations for their approval, and after considerable discussion and some revision it was decided to confine this work to the following lines of experimentation:

First—Sheep and wool investigations, which should include sheep feeding, breeding, and general studies of wool, including the scouring of western wools to determine shrinkage, and such microscopical and chemical investigations as would throw light on the general subject of territorial wools.

Second—Technical investigations in dry farming crops, and the soil moisture behavior under different cultural treatment.

Third—Botanical investigations, including studies of plant diseases, and such branches of economic botany as might be decided upon.

NEED OF STATE HELP.—Some appropriation which does not fall under the general restrictions placed upon the expenditure of government moneys has been a crying need in the Experiment Station for many years. This need is accentuated

rather than decreased through the additional appropriation to the Experiment Station by the Adams fund. The administration of the Adams fund is placed in the hands of the Secretary of Agriculture, who has designated the Director of the Office of Experiment Stations as agent in carrying out the provisions of the act. It has seemed wise to place certain restrictions on the expenditure of this fund, and the Department has taken the stand that it should not be used for the maintenance of farms, or the maintenance of stock. Our greatest problem, therefore, has been, and continues to be, how to use the federal appropriation within the restrictions, and, in the absence of supplemental funds, to provide the necessary equipment and incidental expenses. It has recently been our purpose to make our live stock work one of the most important lines of investigation of the station. From our station funds we cannot properly carry on general farming for the production of feed for our live stock; we cannot pay for membership in live stock associations, nor for advertising any live stock which we might have for sale. The amount of the station funds which could be used for permanent improvements is limited to 5 per cent of the total, so it has not been possible to provide necessary buildings, fences, etc., with which to care for our live stock.

The publication of any results which we might obtain through provisions of the Adams fund must be paid for from other moneys. The government officials very properly expect that the State will meet certain expenses of the nature indicated, in order to show good faith in the expenditure and use of the federal donations.

In carrying out our plans for the sheep and wool investigations under the Adams fund, it will be necessary to provide buildings, fences, and feed, to administer the expenses of publishing the results, and meet the general expenses of maintenance from some other source. A part of this can be met from the Hatch funds, as heretofore, but there are necessary ex-

penditures which the law, strictly interpreted, does not allow from that fund.

Action should be taken by the coming Legislature to supply a small maintenance fund. We are hoping, also, that the old abandoned penitentiary farm and buildings may be turned over to the University for the Agricultural College and the Experiment Station purposes, and an appropriation to properly fit the buildings for this use.

THE LIVE STOCK WORK.—The live stock equipment has been much strengthened during the year. On account of lack of funds to properly equip for the work, it has been decided to abandon our horse-breeding experiments and to cut down, also, the work with cattle to a minimum. Our breeding of Polled Herefords received quite a setback by the loss of Polled Admiral. This bull died of anthrax, but we immediately took occasion to secure another polled bull to take his place.

The sheep and swine work have been enlarged and strengthened, and attention is called to the report of Professor Morton, which gives a technical account of the work with live stock during the year.

PUBLICATIONS.

The regular publications of the station during the year consisted of Bulletins Nos. 67 to 70, inclusive, and the fifteenth annual report. The supplementary publication of *The Ranchman's Reminder* was also continued for the year and the twelve monthly issues contain much matter of interest to the station, and smaller items which were not sufficient for bulletins. The twelve numbers contain a total of 104 pages, and, in addition to the announcement of station publications, and general scientific articles, they have served to advertise the Agricultural College course, our Short Course, and to record the work under the Farmers' Institute law. A brief outline of the station publications follows:

FIFTEENTH ANNUAL REPORT.—This report contains 78 pages, and is made up of the several reports of the Director, financial statements of the Treasurer, outline of the bulletins and work for the present year, a meteorological summary, and the several reports of the members of the Station Staff. The report of the assistant in Animal Husbandry contains the technical data of the feeding of lambs and swine. The report of the Chemist contains a series of tables giving the analysis of Wyoming fodders, a general account of digestion experiments, the determination of the digestibility of alfalfa, and some tables for use in nitrogen and the protein determinations.

BULLETIN NO. 67, August, 1905, "Duty of Water," by B. P. Fleming. This is a 20-page bulletin, prepared for the station by Mr. Fleming after he had resigned and taken up his work at Cornell. The bulletin gives a general discussion of water requirements by crops; a statement of determinations of duty, and methods of measurements; a resume of the duty of water which had previously been determined by measurements at the Experiment Station; and results of the new experiments to determine the amount of water which produces a maximum crop.

BULLETIN NO. 68, October, 1905, "Ration Experiments with Lambs, 1904-05," by Professor Morton, Animal Husbandman of the Station. This is a 24-page bulletin reporting the work done during the year in feeding experiments with lambs. The bulletin is illustrated with cuts of lambs and carcasses, contains a statement of the plans of the experiments, and a discussion of results. The appendix contains a series of tables giving the data of feed consumed, and the gains.

BULLETIN NO. 69, April, 1906, "Digestion Experiments with Wethers, Alfalfa and Native Hay," by Henry G. Knight and Frank E. Hepner, Chemists, and George E. Morton, Animal Husbandman. This is a 42-page bulletin, and contains

a popular discussion of digestion experiments and their relation to direct feeding, and an account of the digestion experiments with sheep carried out through the year by the Experiment Station.

BULLETIN No. 70, May, 1906, "Wyoming Forage Plants and Their Chemical Composition, Studies No. 2," by Henry G. Knight and Frank Hepner, Chemists, and Aven Nelson, Botanist. This is a 76-page bulletin, illustrated with cuts of a large number of grasses of which analyses were made. There is a general description of each variety of grass, some discussion of its occurrence in the State, and tables of analysis of both the native forage and some of the more important cultivated forms.

Report of the Agriculturist and Horticulturist.

The report of the Director of the general plans of work, as printed in this pamphlet, indicates the general lines of work which have been given prominence in the Agricultural Department. It has been impossible for the Professor of Agriculture to do the consecutive work which has been planned in carrying on lines of investigation. The executive work in the station, a considerable amount of teaching in the Agricultural College, and much general mixing in the State's agriculture, have seriously interfered with carrying out investigations and computing the results of such work.

The reorganization of the work for the purpose of laying greater stress on the live stock industry has enabled us to cut down the amount of plot work on the experiment farm to a minimum, and throw a much greater part of the area into the raising of hay and grain for stock feed.

We have begun an important co-operation in Agronomy with the Bureau of Plant Industry of the U. S. Department of

Agriculture. The Cerealist of the Department furnished the Experiment Station with a large number of varieties of barley. These barleys are being grown in rows eighteen inches apart, for the purpose of increasing the seed of the several varieties and at the same time of making studies of them. It is hoped that we may increase this work until it becomes of great importance to the State. The plot on the farm in continuous cropping and in rotation of crops is being carried on, and some work inaugurated to test kinds of potato seed, varieties of pease, and amounts of irrigation to produce a maximum crop of pease.

The horticultural work at Lander, under the bill passed by the last Legislature, which provided for the Horticultural Experimental Commission, has been continued. The Lander experiment farm is leased to Mrs. C. B. Meyer, with the exception of a portion of it which is set aside for the planting of fruits. This work has not been continued sufficiently long to justify a report in detail at this time, but it is hoped that enough will be accomplished to produce material which can be used for a new fruit bulletin to be published by the station.

We have begun active work in dry farm investigations, and are co-operating with the Office of Irrigation Investigations in carrying on the dry farm experiments at Cheyenne. Mr. Nowell is in charge of the soil moisture determinations at Cheyenne, and much data is accumulating which promises to be of value.

FARMERS' INSTITUTES.—The following table gives briefly a general resume of the Farmers' Institutes carried out during the year under the new state law. This work is doing much good in the State and is helpful to the Experiment Station in that it brings greater sympathy and support to us from our own people, and it also enables us to carry the results of our work out to the farmers in the most effective and convincing way:

FARMERS' INSTITUTES AND SHORT COURSES.

No.	Date	Place	No. meetings	Total attendance	LECTURERS	Cost
1	Mch. 29, 30, 31, 1905	Cody	6	340	Buffum, Nelson, Morton.	$ 92.90
2	Dec. 28, 29, 30, 1905	Cody	9	300	Buffum, Morton.	73.50
3	Jan. 5 to 13, 1906. .	Laramie. . .	17	625	Gov. Brooks, Johnston, Morton, Buffum, McLean, Gaumnitz, Glover, Bell, Knight.	169.89
4	Feb. 22, 23, 1906. .	Wheatland .	5	348	Buffum, Morton, Nelson, Nowell, Wherren, Bliss, Helm, (Stewart, operator)	
5	Feb. 26, 27, 1906. .	Lander . . .	5	281	Buffum, Morton, Camp, (Stewart, operator)	
6	Mch. 5, 1906. . . .	Thermopolis	2	229	Buffum, Morton, Camp (Stewart, operator)	502.55
7	Mch. 6, 1906. . . .	Worland . .	2	98	Buffum, Morton, Camp (Stewart, operator)	
8	Mch. 8, 1906. . . .	Basin. . . .	1	270	Buffum, Camp (Stewart, operator)	
9	Mch. 12, 13, 1906. .	Buffalo . . .	4	152	Buffum, Nelson, Morton, Camp, (Stewart, operator).	
10	Mch. 30, 31, 1906. .	Evanston . .	5	450	Buffum, Morton, Knight, Camp, (Stewart, operator).	186.95
11	April 14, 1906 . . .	Encampment	3	139	Buffum, Knight, Nowell	
12	May 2, 3, 1906. . .	Lusk	5	189	Buffum, Nelson, Morton	81.80
12	28 days	11	64	3401		$1107.59

Financial Statement of the Treasurer.

UNIVERSITY OF WYOMING.
AGRICULTURAL EXPERIMENT STATION
IN ACCOUNT WITH
THE UNITED STATES APPROPRIATION, 1905-1906.

DR.

To receipts from the Treasurer of the United States, as per appropriation for fiscal year ending June 30, 1906, as per act of Congress approved March 2, 1887, and March 16, 1906—Hatch Fund $15,000.00
Adams Fund 5,000.00

CR.

	Adams	Hatch	
By Salaries	......	$7,703.63	
Labor	......	1,528.97	
Publications	......	1,187.57	
Postage and stationery	......	244.02	
Freight and express	$ 4.75	257.02	
Heat, light, water, and power	......	700.00	
Chemical supplies	621.38	308.89	
Seeds, plants, and sundry supplies	......	355.45	
Feeding stuffs	......	976.63	
Library	......	12.05	
Tools, implements, and machinery	352.07	476.40	
Furniture and fixtures	......	139.23	
Scientific apparatus	301.80	87.35	
Live stock	3,700.00	175.17	
Traveling expenses	20.00	365.58	
Contingent expenses	......	25.00	
Buildings and repairs	......	457.04	
Totals	$5,000.00	$15,000.00	$20,000.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1906; that

we have found the same well kept and classified as above; and that the receipts for the year from the Treasurer of the United States are shown to have been $20,000.00 and the corresponding disbursements $20,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887, and the act of Congress approved March 16, 1906. [Signed] T. F. BURKE,

B. A. STONE,

H. L. STEVENS,

Auditors.

Attest:

GRACE RAYMOND HEBARD,

(SEAL) Custodian.

SUPPLEMENTARY STATEMENT.

DR.

	Farm Products	*State*	*Total*
To receipts from other sources than the United States for the year ending June 30, 1906	$2,608.30	$177.26	$2,785.56

CR.

Heat, light, water, and power	$ 38.01	$177.26	....
Postage	50.00	....	....
Furniture	154.96	....	....
Live stock	2,075.33	....	....
Building and repairs	290.00	....	$2,785.56

Report of the Animal Husbandman.

STOCK FEEDING EXPERIMENTS.—The following ration experiments were conducted with range lambs:

Lot 2—Native hay, oats.
Lot 4—Native hay, corn.
Lot 6—Native hay, corn, oil meal.
Lot 8—Native hay, oats, oil meal.
Lot 10—Native hay, barley, oil meal.
Lot 12—Native hay, barley.
Lot 14—Alfalfa, corn.
Lot 1—Alfalfa, corn.
Lot 16—Peas in field.

A summary of the above work will be found further on in this report; also in a bulletin to be published during the year 1906-07.

Swine feeding work was discontinued because of lack of labor.

DIGESTION EXPERIMENTS.—The digestion experiments started in 1904-05 have been continued with the two wethers used during that year and with a Shropshire wether. For a detailed report of these experiments, see report of the chemists in this volume. The experiments were conducted in co-operation with the Department of Chemistry.

BREEDING EXPERIMENTS.—The breeding of Polled Herefords, and the gathering of data concerning the relative influence of parents upon offspring, has been continued, and a report will be made next year.

LIVE STOCK ACQUISITIONS, AND ADDITIONS TO EQUIPMENT.—The sheep work has been enlarged by the addition of Shropshire and Oxford Down ewes. Berkshire hogs have been added to the swine equipment. Several acre and half-acre lots have been enclosed by woven wire fencing to provide facil-

ities for experimental feeding of swine upon alfalfa pasture, and individual hog houses have been erected upon these pastures. A number of close board corrals have been erected for the accommodation of cattle.

OTHER DEPARTMENTAL WORK.—The live stock work, formerly administered as a division of the Agricultural Department, has been broadened to constitute a department of itself—the Department of Animal Husbandry, in charge of the animal husbandman.

Two bulletins have been issued during the year: Bulletin 68, "Ration Experiments with Lambs, 1904-05," and Bulletin 69, "Digestion Experiments with Wethers," published in coöperation with the Department of Chemistry.

A classification of agricultural literature has been developed by the Animal Husbandman, and will be found appended to this report.

Some of the Station live stock was exhibited at the local county and state fairs, and the following prizes were taken:

Albany County and Inter-Mountain Fair:

Two-year-old Hereford bull, first prize, on Polled Admiral.

One-year-old Hereford bull, third prize, on George.

Wyoming State Fair:

Two-year-old Hereford bull, second prize, on Polled Admiral.

One-year-old Hereford bull, second prize, on George.

Rambouillet ewe, 2 years old or over, first prize and sweepstakes, on A. E. Green No. 625; third prize, on A. E. Green No. 540.

Ewe, any age or breed, sweepstakes, on A. E. Green No. 625.

FARMERS' INSTITUTES.—The instruction in live stock subjects, at the various Farmers' Institutes in the State, were handled by the animal husbandman.

G. E. MORTON,
Animal Husbandman.

SUMMARY OF LAMB FEEDING, 1905-06.

BY THE ANIMAL HUSBANDMAN.

Two series of experiments were run; the first comprising Lots 2 to 14, aimed to discover the best grain ration to feed with native hay; the second series, comprising Lots 1 and 16, constitutes a practical test of field pea feeding compared with an alfalfa and corn ration. Table A shows the outline of the experiment, and the succeeding tables give data from which the value of the various rations may be deduced.

TABLE A.

LOT	Number in Lot	Average Weight per Head	ROUGHAGE	GRAIN RATION
2	5	63.6	Native Hay	Oats
4	5	63.8	Native Hay	Corn
6	5	63.8	Native Hay	Corn, Oil Meal
8	5	63.6	Native Hay	Oats, Oil Meal
10	5	63.6	Native Hay	Barley, Oil Meal
12	5	63.4	Native Hay	Barley
14	5	63.4	Alfalfa	Corn
1	100	59.0	Alfalfa	Corn
16	100	58.1	Peas in field	Peas in field

TABLE B—*Feed and Gain per Head, Fourteen Weeks.*

LOT	RATION	Average gain per head lbs.	AVERAGE FEED PER HEAD. LBS. Alfalfa	Native Hay	Corn	Barley	Oats	Oil Meal	Peas in field
2	Oats and Native Hay	15.0	...	98.	...	...	109.	...	...
4	Corn and Native Hay	12.8	...	98.	84.	...	...	...	...
6	Corn, Oil Meal, Native Hay	16.6	...	99.	85.	...	...	16.4	...
8	Oats, Oil Meal, Native Hay	17.4	...	100.	...	...	103.	15.1	...
10	Barley, Oil Meal, Native Hay	16.8	...	99.	...	90.	...	16.3	...
12	Barley, Native Hay	16.0	...	105.	...	92.	...	...	...
14	Corn, Alfalfa	28.6	167	...	109.	...	...	...	...
1	Corn, Alfalfa	31.2	213	...	91.	...	...	...	...
16	Peas in field	20.0	...	...	...	...	...	...	1/8a

TABLE C—*Cost of 100 Pounds Gain, and Nutritive Ratio.*
(Compiled from Tables XII and XVII.)

LOT	RATION	Cost of 100 lbs Gain	Nutritive Ratio
2	Native Hay, Oats	$8.89	9.4
4	Native Hay, Corn	8.48	11.2
6	Native Hay, Corn, Oil Meal	8.60	8.3
8	Native Hay, Oats, Oil Meal	9.07	7.4
10	Native Hay, Barley, Oil Meal	8.77	7.3
12	Native Hay, Barley	7.38	9.3
14	Alfalfa, Corn	5.28	5.4
1	Alfalfa, Corn	4.63	5.6
16	Peas in field	5.00	—

Native Hay and Alfalfa, $5 per ton.
Corn, Oats and Barley, $1 per cwt.
Oil Meal, $2 per cwt.
Peas in field, $8 per acre.

TABLE D—*Digestible Nutrients for Gain.*
(Compiled from Tables XI and XVII.)

LOT	RATION	GAIN per Head lbs.	Lbs. Digestible Nutrients for 100 lbs. gain: Protein	Lbs. Digestible Nutrients for 100 lbs. gain: Carbohydrates and fats (Factor 2.4)	Nutritive Ratio
2	Native Hay, Oats	15.0	85	804	9.4
4	Native Hay, Corn	12.8	83	923	11.2
6	Native Hay, Corn, Oil Meal	16.6	93	771	8.3
8	Native Hay, Oats, Oil Meal	17.4	98	722	7.4
10	Native Hay, Barley, Oil Meal	16.8	102	730	7.3
12	Native Hay, Barley	16.0	81	754	9.3
14	Alfalfa, Corn	28.6	100	538	5.4
1	Alfalfa, Corn	31.2	106	588	5.6

TABLE E—*Shrink and Yield of Lambs.*

LOT	Number Shipped	Av'ge Shipping Weight	Av'g Shrink bet. Laramie and Valley, Neb. 40 hrs.*	Average Fill at Valley 10 hr.	Average Shrink Valley to Omaha 38 mi.	Average Market Weight	Per cent. Dressed	Market Price
1	90 tops	93.8 lbs.	9.8 lbs.	2.1 lbs.	.5 lb.	85.6	55.45	$7.10
16	90 tops	79.1 lbs.	5.6 lbs.	3.5 lbs.	.8 lb.	76.2	55.35	7.00

*538 miles; lambs were unloaded and fed at North Platte, Neb., 11 hours of the 40; but there were no facilities for feeding; the alfalfa hay was stemmy and bleached and the only water available was in a cattle trough so high that few of the lambs would attempt to drink rom it.

TABLE I—*Weekly Data, Lot 2.*
(Five lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Average Gain per Head lbs.	FEED, LBS.	
				Native Hay	Oats
Beginning	318	......	......	......	......
First Week	326	8	1.6	35.	23.75
Second Week	337	11	2.2	37.	32.25
Third Week	351	14	2.8	35.	36.
Fourth Week	342	—9	—1.8	35.	38.
Fifth Week	351	9	1.8	35.	36.25
Sixth Week	365	14	2.8	39.5	42.
Seventh Week	367	2	.4	38.	42.5
Eighth Week	372	5	1.	34.5	45.5
Ninth Week	382	10	2.	34.	48.5
Tenth Week	380	—2	—.4	28.5	43.75
Eleventh Week	381	1	.2	35.	40.5
Twelfth Week	383	2	.4	35.	38
Thirteenth Week	388	5	1.	35.	40.5
Fourteenth Week	393	5	1.	35.	38.5
	......	75	15	491.5	544.00

TABLE II—*Weekly Data, Lot 4.*
(Five lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Av. Gain per Head lbs.	FEED LBS.	
				Native Hay	Corn
Beginning	319	......	......	......	......
First week	317	—2	—.4	35	21
Second week	328	11	2.2	29	28.75
Third week	333	5	1	35	24
Fourth week	323	—10	—2	35	23.5
Fifth week	320	—3	—.6	35	21
Sixth week	335	5	3	30.5	25.5
Seventh week	344	19	1.8	38	32.5
Eighth week	350	6	1.2	35	35
Ninth week	359	9	1.8	35	35.75
Tenth week	363	4	.8	35	38.5
Eleventh week	360	—3	—.6	35	30.5
Twelfth week	372	12	2.4	35	34.5
Thirteenth week	378	6	1.2	35	35
Fourteenth week	383	5	1	35	35
....	......	64	12.8	491.5	420.5

TABLE III—*Weekly Data, Lot 6.*
(Five lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Av. Gain per Head lbs.	FEED, LBS.		
				Native Hay	Corn	Oil Meal
Beginning	319	....	......	......	......	.....
First week	322	3	.6	35	17.5	1.75
Second week	337	15	3	37	29	4.31
Third week	344	7	1.4	35	31.5	4.37
Fourth week	337	—7	—1.4	35	29	4.75
Fifth week	327	—10	—2	32.5	22.5	5.44
Sixth week	351	24	4.8	39.5	27.75	6.13
Seventh week	356	5	1	38	27.75	6.13
Eighth week	360	4	.8	35	35	7
Ninth week	370	10	2	35	35	7
Tenth week	370	0	0	35	35	7
Eleventh week	371	1	.2	35	33	7
Twelfth week	390	19	3.8	35	34.5	7
Thirteenth week	395	5	1	35	35	7
Fourteenth week	402	7	1.4	35	35	7
....	....	83	16.6	497	427.1	81.88

TABLE IV—*Weekly Data, Lot 8.*
(Five lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Av. Gain per Head lbs.	FEED, LBS.		
				Native Hay	Oats	Oil Meal
Beginning	318	....	......	......	......	.....
First week	327	9	1.8	35	21.5	1.75
Second week	344	17	3.4	37	30	4.00
Third week	346	2	.4	35	32.5	4.37
Fourth week	342	—4	—.8	35	34.5	4.88
Fifth week	345	3	.6	35	35	6.13
Sixth week	358	13	2.6	39.5	35	6.13
Seventh week	363	5	1	38	35.25	6.13
Eighth week	365	2	.4	35	38.5	7
Ninth week	370	5	1	35	41.5	7
Tenth week	382	12	2.4	35	42	7
Eleventh week	382	0	0	35	42	7
Twelfth week	392	10	2	35	42	7
Thirteenth week	399	7	1.4	35	42	7
Fourteenth week	405	6	1.2	35	42	7
....	.....	87	17.4	499.5	513.75	75.39

TABLE V—*Weekly Data, Lot 10.*
(Five lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Av. Gain per Head lbs.	FEED, LBS.		
				Native Hay	Barley	Oil Meal
Beginning	318	....	......	......	......	.....
First week	328	10	2	35	20.25	1.75
Second week	332	4	.8	37.5	29	4.31
Third week	342	10	2	35	29.75	4.38
Fourth week	334	—8	—1.6	35	32.5	4.75
Fifth week	348	14	2.8	30	34.5	6.12
Sixth week	365	17	3.4	39.5	35	6.12
Seventh week	359	—6	—1.2	38	24	5
Eighth week	365	6	1.2	35	35	7
Ninth week	376	11	2.2	35	35	7
Tenth week	378	2	.4	35	35	7
Eleventh week	375	—3	—.6	35	35	7
Twelfth week	392	17	3.4	35	35	7
Thirteenth week	395	3	.6	35	35	7
Fourteenth week	402	7	1.4	35	35	7
....	......	84	16.8	495	450	81.43

TABLE VI—*Weekly Data, Lot 12.*
(Five lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Av. Gain per Head lbs	FEED, LBS.	
				Native Hay	Barley
Beginning	317	......	......	....	....
First week	328	11	2.2	35	23
Second week	337	9	1.8	37	32.25
Third week	342	5	1	35	33
Fourth week	328	—14	—2.8	35	30.5
Fifth week	330	2	.4	35	28.75
Sixth week	349	19	3.8	39.5	32.25
Seventh week	358	9	1.8	41	35
Eighth week	363	5	1	37.5	35
Ninth week	365	2	.4	35	35
Tenth week	355	—10	—2	35	35
Eleventh week	371	16	3.2	35	35
Twelfth week	389	18	3.6	40.5	35
Thirteenth week	390	1	.2	41	35
Fourteenth week	397	7	1.4	42	35
....	......	80	16	523.5	459.75

TABLE VII—*Weekly Data, Lot 14.*
(Five lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Av. Gain per Head lbs.	FEED, LBS.	
				Alfalfa	Corn
Beginning	317	......	......	......	......
First week	312	—5	—1	35	21.25
Second week	330	18	3.6	38	32.5
Third week	336	6	1.2	42	35
Fourth week	342	6	1.2	43	32.75
Fifth week	350	8	1.6	52	37
Sixth week	384	34	6.8	66	38.5
Seventh week	385	1	.2	70	38.5
Eighth week	390	5	1	70	42
Ninth week	405	15	3	70	42
Tenth week	415	10	2	70	45
Eleventh week	425	10	2	70	45.5
Twelfth week	444	19	3.8	70	45.5
Thirteenth week	455	11	2.2	70	45.5
Fourteenth week	460	5	1	70	45.5
....	....	143	28.6	836	546.5

TABLE VIII—*Weekly Data, Lot 1.*
(One hundred lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Av. Gain per Head lbs.	FEED, LBS.	
				Alfalfa	Corn
Beginning	5899	......	......	......	......
First week	6072	173	1.73	980	320
Second week	6408	336	3.36	1120	513
Third week	6727	319	3.19	1195	564
Fourth week	6750	23	.23	1312	686
Fifth week	6953	203	2.03	1400	730
Sixth week	7275	322	3.22	1490	700
Seventh week	7605	330	3.30	1540	700
Eighth week	7751	146	1.46	1540	700
Ninth week	7813	62	.62	1670	700
Tenth week	7913	100	1.00	1800	700
Eleventh week	8209	296	2.96	1820	700
Twelfth week	8572	363	3.63	1820	700
Thirteenth week	8864	292	2.92	1820	724
Fourteenth week	9023	159	1.59	1820	700
....	.....	3124	31.24	21327	9117

TABLE IX—*Weekly Data, Lot 16.*
(One hundred lambs in lot.)

	WEIGHT lbs.	GAIN lbs.	Av. Gain per Head lbs.	FEED
Beginning	5807	. . . . .	. . . . .	. . . . .
First week	5718	—89	—.89	. . . . .
Second week	5900	182	1.82	. . . . .
Third week	6041	141	1.41	
Fourth week	6465	424	4.24	12½ acres of Peas.
Fifth week	6435	—30	—.30	
Sixth week	6496	61	.61	Fair Crop for
Seventh week	6961	465	4.65	
Eighth week	7017	56	.56	Laramie Plains
Ninth week	7143	126	1.26	
Tenth week	7264	121	1.21	. . . . .
Eleventh week	7446	182	1.82	. . . . .
Twelfth week	7648	202	2.02	. . . . .
Thirteenth week	7749	101	1.01	. . . . .
Fourteenth week	7805	56	.56	. . . . .
. . . . .	. . . . .	1998	19.98	. . . . .

TABLE X—*Feed, All Lots.*
(Compiled from Tables I to IX.)

LOT	No. in Lot	Total Feed for 14 weeks, lbs.						Average Feed Per Head. 14 weeks, lbs.						
		Alfalfa	Native Hay	Corn	Barley	Oats	Oil Meal	Alfalfa	Native Hay	Corn	Barley	Oats	Oil Meal	Peas in Field
2	5	. . .	491.5	. . .	. . .	544	. . .	. . .	98.3	. . .	. . .	108.8	. . .	. . .
4	5	. . .	491.5	420.5	. . .	. . .	. . .	. . .	98.3	84.1	. . .	. . .	. . .	. . .
6	5	. . .	497	427.1	. . .	. . .	81.88	. . .	99.4	85.4	. . .	. . .	16.38	. . .
8	5	. . .	499.5	. . .	. . .	513.75	75.39	. . .	99.9	. . .	. . .	102.75	15.08	. . .
10	5	. . .	495	. . .	450	. . .	81.43	. . .	99.0	. . .	90	. . .	16.28	. . .
12	5	. . .	523.5	. . .	450.8	. . .	. . .	. . .	104.7	. . .	91.95	. . .	. . .	. . .
14	5	836	. . .	546.5	. . .	. . .	. . .	167.2	. . .	109.3	. . .	. . .	. . .	. . .
1	100	21,327	. . .	9,117.0	. . .	. . .	. . .	213.27	. . .	91.17	. . .	. . .	. . .	. . .
16	100	Peas in field, 12½ acres						. . .	. . .	. . .	. . .	. . .	. . .	⅛acre

TABLE XI—*Weights and Gains, All Lots.*
(Compiled from Tables I to IX.)

LOT	No. in Lot	Initial Weight lbs.	Closing W't lbs.	Total Gain lbs.	Average Gain per Head, lbs.
2	5	318	393	75	15.0
4	5	319	383	64	12.8
6	5	319	402	83	16.6
8	5	318	405	87	17.4
10	5	318	402	84	16.8
12	5	317	397	80	16.0
14	5	317	460	143	28.6
1	100	5899	9023	3124	31.24
16	100	5807	7805	1998	19.98

TABLE XII—*Feed Required for Gain, All Lots.*
(Compiled from Tables X and XI.)

LOT	RATION	GAIN per Head	Pounds Feed for 100 pounds Gain						
			Alfalfa	Native Hay	Corn	Barley	Oats	Oil Meal	Peas in field
2	Oats and Native Hay	15.0	. . .	6.55	. . .	. . .	7.25	. . .	. .
4	Corn and Native Hay	12.8	. . .	7.67	6.56	. . .	. . .	. . .	. .
6	Corn, Oil Meal, Native Hay	16.6	. .	5.98	5.14	. . .	. . .	9.8	. .
8	Oats, Oil Meal, Native Hay	17.4	. . .	5.74	. . .	. . .	5.91	8.6	. .
10	Barley, Oil Meal, Native Hay	16.8	. . .	5.89	. . .	5.36	. . .	9.7	. .
12	Barley, Native Hay	16.0	. . .	6.54	. . .	5.75	. . .	. . .	. .
14	Corn, Alfalfa	28.6	5.84	. . .	3.82	. . .	. . .	. . .	. .
1	Corn, Alfalfa	31.2	6.82	. .	2.92	. . .	. . .	. . .	. .
16	Peas in field	20.0	. . .	. . .	. . .	. . .	. . .	. . .	[illegible]

TABLE XIII—*Composition of Feeding Stuffs.*

	Crude Protein	Crude Fibre	Nitrogen Free Extract	Ether Extract
* Alfalfa	16.45	29.78	35.13	1.94
† Native Hay (mixed grasses)	8.44	30.82	45.95	2.17
† Corn	9.25	2.03	71.92	4.33
† Barley	12.44	5.80	66.72	2.01
† Oats	9.60	11.50	59.96	6.92

* Bulletin 69, Wyoming Experiment Station.
† Analyses by F. E. Hepner, Assistant Chemist, Wyoming Experiment Station.

TABLE XIV—*Digestibility of the Feeding Stuffs.*

	Crude Protein	Crude Fibre	Nitrogen Free Extract	Ether Extract
* Alfalfa	76	44	72	35
* Native Hay (mixed grasses)	56	70	68	42
† Corn	76	58	93	86
‡ Barley	70	50	92	69
‡ Oats	78	20	76	83

* Bulletin 69, Wyoming Experiment Station.
† Zusammensetzung der Fuettermittel, Dietrich and Koenig.
‡ Mentzel and Lengerke's Landn. Kalender for 1898, through Henry's Feeds and Feeding.

TABLE XV—*Digestible Nutrients in the Feeding Stuffs.*
(Compiled from Tables XIII and XIV.)

	DIGESTIBLE NUTRIENTS IN 100 LBS.		
	Protein	Carbohydrates	Ether Ext.
Alfalfa	12.5	38.4	.7
Native Hay (mixed grasses)	4.7	52.8	.9
Corn	7.0	68.1	3.7
Barley	8.7	64.3	1.8
Oats	7.6	47.9	5.7
* Oil Meal	29.3	32.7	7.0

* From Henry's Feeds and Feeding.

TABLE XVI—*Amount of Digestible Nutrients Eaten, Fourteen Weeks.*
(Compiled from Tables X and XV.)

LOT	PROTEIN	CARBOHYDRATES	ETHER EXTRACT
2	64.44	520.09	34.45
4	52.54	545.87	19.00
6	77.25	580.05	25.01
8	84.61	534.47	39.07
10	86.31	577.34	18.05
12	64.60	572.03	12.99
14	142.76	705.45	28.74
1	3304.07	15566.24	1167.88

TABLE XVII—*Digestible Nutrients and Nutritive Ratio.*
(Compiled from Table XVI.)

LOT	PROTEIN	CARBOHYDRATES AND FATS (Factor 2.4)	NUTRITIVE RATIO
2	64	603	9.4
4	53	591	11.2
6	77	640	8.3
8	85	628	7.4
10	86	621	7.3
12	65	603	9.3
14	143	770	5.4
1	3304	18369	5.6

SOME COMPARISONS AND CONCLUSIONS.

Lot 2—Native hay, oats.
Lot 4—Native hay, corn.
Lot 6—Native hay, corn, oil meal.
Lot 8—Native hay, oats, oil meal.
Lot 10—Native hay, barley, oil meal.
Lot 12—Native hay, barley.
Lot 14—Alfalfa, corn.

None of the native hay rations were as satisfactory as corn and alfalfa.

Hulled barley and native hay proved to be the most economical of the native hay rations.

Oil meal, fed with native hay and grain, increases the cost of gain, although it produces slightly greater gains than native hay and grain without oil meal. When fed with corn and native hay, it produces enough greater gains to make the ration practically equal in cost to the native hay and corn ration, and the extra degree of fatness in the lambs brings a better price in the market.

Native hay and corn is shown by this test, and by another test published in Bulletin No. 68, to be unsatisfactory as a lamb feeding ration.

Lot 1—Alfalfa, corn.
Lot 16—Peas in field.

Field peas, grazed off, showed returns approximately equaling the returns from feeding alfalfa and corn, with the pease valued at $8 per acre, alfalfa at $5 per ton, and corn at $1 per cwt.; although the alfalfa and corn lambs gained about one-half more than the pea lambs.

The corn and alfalfa lambs, which were 11 pounds per head heavier than the pea lambs when shipped, shrank 4.2 pounds more than the pea lambs in a railroad run of 538 miles.

The law requiring the unloading of live stock at the end of 28 or 36 hours works a hardship in many cases, because the stock is unloaded at stock yards where there are not proper facilities for the care of the stock. This could be remedied by the placing of well equipped feeding yards at more frequent intervals.

Report of the Chemists.

Until last year, such agricultural research work in chemistry as was undertaken was done in a part of the food laboratory set apart for that purpose. This was very unsatisfactory, as it made very close quarters. The first of last October a laboratory was fitted out for agricultural work exclusively, and since then the work has been carried on continuously and more has been accomplished than heretofore. This department in consequence has been raised from one of comparative insignificance to one which we believe will compare favorably with others in this station.

For a number of years past (since 1903) food investigation has been a regular work in chemistry, as provided by state law. (Chapter 82, Session Laws of 1903.) A regular assistant is provided for this work, and Mr. Ross B. Moudy has held the position. During the past year 353 samples of foods, drinks, drugs and oils have been analyzed, of which number 237, or 67 per cent, have been found to be pure and 116, or 33 per cent, have been reported adulterated or misbranded. It is believed that the food conditions are becoming better throughout the state. A fight has been made against coloring matter and chemical preservatives in food products, and there is a noticeable falling off in their use. The prohibition of the use of coloring matter has tended to reduce other adulteration. Glucose is not used as extensively as formerly, and where it is used in most cases it is mentioned on the label.

The Legislature in the session of 1905 provided for the establishment of the office of Dairy, Food and Oil Commissioner, prescribing his powers and duties. (See Chapter 49, Session Laws of 1905.)

Mr. E. W. Burke was appointed to that office as the pioneer to open the way. Being the first in office, he could not

be guided by the policy of others, so that the work has been quite well stamped with his personality. Until February 9th, 1906, no cases were taken into court, except emergency cases, and the time was spent taking up the laws with the merchants individually, as far as possible, collecting samples, and publishing and distributing literature, such as bulletins. In the bulletins legal goods, as well as illegal goods, were noted and given equal prominence. Since February 9th, 1906, all cases reported illegal from the office of State Chemist were taken into court. It has been the policy of the Commissioner to make the manufacturers or jobbers assume the responsibility, when possible, rather than to bring the cases against the retail dealers throughout the state, as the retail merchants are dependent almost wholly upon the honesty and integrity of the manufacturer's or jobber's agent. This policy has tended to bring the Commission and the merchants into a closer friendly relation.

The work is, however, very much handicapped, as many of the states around us have practically no food laws, or have not the means of enforcing what they have. Moreover, those states where raw material is a product are inclined to show leniency to those manufacturers who handle them; but it is believed with the passage of the national food laws conditions will in general be much better, and that manufacturers who are endeavoring to put out honest goods will be able to carry on business with the different states more economically.

During the past year the following lines of investigation in agricultural chemical research have been pursued:

I. Forage plant investigation (in co-operation with the Department of Botany).

II. Digestion experiments with wethers (in co-operation with the Department of Animal Husbandry).

III. Alkali studies.

IV. Miscellaneous work.

These will be taken up and discussed in the order given. Most of the time of the station staff in this department has been devoted to investigations embodied under heads I and II, as given above.

I. *Forage Plant Investigations.* This work is a continuation of the work along this line pursued during the year 1904-5. A number of forage plants have been investigated, and during the past year Bulletin No. 70, "Wyoming Forage Plants and Their Chemical Composition—Studies No. 2," has been published, containing the descriptions and analyses of over thirty plants. This, with Bulletin No. 65, the first of the series, represents the work accomplished in this field up to date.

Many of the common forage plants which are indigenous to this altitude (seven to eight thousand feet) have been taken up and studied. It is the intention to extend the work still further in the future, and it is hoped that we will be able to to make collections of plants growing at much higher and also lower altitudes in the state, that comparisons may be made and to determine, if possible, the effect that difference in altitude and climatic conditions may produce.

It is the practice to range stock, during the summer months, in the mountain parks, which vary in elevations from 8,000 and 13,000 feet, and it is thought by many that the forage is more nutritious, if anything, than forage flourishing at low altitudes.

Below will be found a summary of the forage plant analyses contained in Bulletin No. 70, "Wyoming Forage Plants and Their Chemical Composition—Studies No. 2":

	GREEN						AIR-DRY				
	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	Water	Ash	Ether extract	Crude fiber	Crude protein
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Agropyron caninum (L.) Beauv.	53.23	2.81	0.92	17.34	3.88	21.82	5.73	5.67	1.85	34.96	7.81
Agropyron occidentale Scribn.	49.27	2.70	1.18	18.32	2.76	25.77	5.80	5.02	2.19	34.02	5.12
Agropyron violaceum (Hornem.) Lange	52.72	2.43	1.97	14.70	5.17	23.01	6.33	4.81	3.90	29.12	10.25
Agrostis hyemalis (Walt.) B. & P.	57.15	2.85	1.01	14.10	3.52	21.37	5.63	6.28	2.23	31.05	7.75
Alopecurus fulvus J. E. Smith	68.94	3.79	1.24	8.41	3.58	14.04	6.26	11.43	3.74	25.37	10.81
Beckmannia erucaeformis (L.) Host.	66.74	2.52	0.51	12.71	2.10	15.42	6.14	7.10	1.45	35.85	5.94
" "	60.77	2.67	0.79	13.59	2.96	19.22	7.56	6.29	1.87	32.02	6.97
Bouteloua oligostachya (Nutt.) Torr.	55.37	2.17	0.63	15.48	3.68	22.67	6.00	4.57	1.34	32.60	7.75
Bromus marginatus Nees	66.27	2.64	0.45	12.87	2.64	15.54	5.32	7.42	1.27	36.11	6.25
Bromus Porteri (Coult.) Nash	60.11	2.17	0.74	16.67	3.24	17.07	5.24	5.17	1.75	39.60	7.69
Calamagrostis canadensis (Michx.) Beauv.	54.21	3.08	1.27	15.12	3.15	23.17	6.31	6.31	2.60	30.93	6.44
Calamagrostis canadensis acuminata Vasey	64.91	4.19	0.72	12.17	3.58	14.43	5.53	11.27	1.93	32.78	9.63
Carex Liddoni Boott.	51.79	4.55	0.81	15.30	2.77	24.78	6.27	8.84	1.58	29.74	5.38
Carex marcida Boott.	43.53	4.44	1.91	16.09	3.98	30.05	5.89	7.39	3.19	26.82	6.6[illegible]
Carex nebraskensis Dewey	65.92	2.85	0.92	10.77	3.28	16.26	6.42	7.83	2.54	29.56	9.00
" "	62.28	4.19	1.13	10.89	2.53	18.98	6.82	10.35	2.80	26.89	6.25
Deschampsia caespitosa Beauv.	58.58	3.21	0.50	16.67	2.90	18.14	5.29	7.33	1.15	38.13	6.6[illegible]
Deschampsia caespitosa Beauv.	51.06	3.34	0.89	17.78	3.09	23.84	6.27	6.39	1.70	34.06	5.91
Eleocharis palustris (L.) R. & S.	71.82	3.29	0.57	9.08	3.18	12.06	5.21	11.07	1.92	30.55	10.69
Elymus condensatus Presl.	60.22	2.22	0.44	18.04	2.23	16.85	5.31	5.28	1.05	42.94	5.31
Festuca Kingii (Wats.) Scribn.	59.92	2.56	0.97	15.19	3.03	18.33	5.78	6.03	2.27	35.70	7.13
Hedysarum philoscia A. Nels.	67.20	1.68	0.65	8.91	4.72	16.84	7.76	4.73	1.83	25.06	13.9[illegible]
Hordeum nodosum L.	56.75	2.37	1.14	13.30	5.05	21.39	6.21	5.16	2.46	28.84	10.94
Juncus balticus Willd.	56.37	1.81	0.78	14.94	3.14	22.96	5.47	3.91	1.68	32.38	6.81
Juncus longistylis Torr.	67.39	1.81	0.39	12.81	2.01	15.59	5.71	5.24	1.14	37.03	5.81
Koeleria cristata Pers.	58.44	2.71	0.72	16.12	2.69	19.32	6.48	6.09	1.61	36.28	6.06
Melilotus alba Desv.	86.08	1.65	0.29	3.33	3.32	5.33	6.88	11.03	1.96	22.27	22.19
Panicularia americana (Torr.) MacM.	72.37	2.06	0.34	10.46	2.40	12.37	6.30	6.99	1.17	35.47	8.13
" "	64.51	3.56	0.75	10.25	2.94	17.99	5.83	9.45	1.99	27.19	7.81
Panicularia nervata (Willd.) Kuntze.	67.33	2.46	0.59	10.58	2.44	16.60	7.16	6.98	1.67	30.07	6.94
Phleum alpinum L.	61.06	1.49	0.69	15.47	1.95	19.34	4.98	3.63	1.69	37.76	4.75
Phleum pratense L.	73.47	1.82	0.51	10.11	1.91	12.18	5.96	6.46	1.82	35.85	6.75
Poa Buckleyana Nash	65.03	2.61	0.50	14.55	2.69	14.62	5.94	7.02	1.34	39.13	7.25
" "	48.67	2.33	1.24	18.87	3.52	25.37	6.10	4.27	2.26	34.52	6.44
Poa nevadensis Vasey	42.39	2.91	1.19	19.40	4.05	30.06	5.76	4.76	1.94	31.74	6.63
Sporobolus brevifolius (Nutt.) Scribn.	50.96	2.88	1.01	15 00	3.78	26.37	6.76	5.47	1.93	28.52	7.19
" "	49.12	3.02	0.99	18.05	3.03	25.79	6.45	5.56	1.82	33.19	5.56
Thermopsis divaricarpa A. Nels.	69.90	1.72	0.86	8.11	4.56	14.85	7.69	5.27	2.65	24.86	14.00
Native hay	...	...	...	...	...	...	6.07	5.61	1.64	30.95	7.56

WATER-FREE				
Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	When and Where Gathered, Soil, and Condition of Sample
per cent	*per cent*	*per cent*	*per cent*	
1.96	37.09	8.28	46.65	July 29, 1905, dry benches, Crow creek. Near blooming period.
[illegible].32	36.11	5.44	50.80	Aug. 14, 1905, dry gravelly soil near Little Laramie. Bloom.
[illegible].16	31.09	10.94	48.67	July 29, 1905, dry benches, Crow creek. In bloom.
[illegible].36	32.90	8.21	49.87	July 29, 1905, moist land, Crow creek. Near blooming period.
[illegible].99	27.07	11.53	45.22	Sept. 7, 1905, sandy soil at water's edge, Boswell ranch. Both fruit and flowers.
1.54	38.20	6.33	46.37	July 29, 1905, irrigated meadow, Crow creek.
[illegible].02	34.64	7.54	49.00	Sept. 7, 1905, near irrigating ditch in meadow, Boswell ranch. In fruit; quite ripe.
1.43	34.68	8.24	50.79	Aug. 12, 1905, gravelly soil, near Little Laramie. Bloom.
1.34	38.14	6.60	46.08	July 29, 1905, dry benches, Crow creek. Near blooming period.
1.85	41.79	8.11	42.79	July 29, 1905, dry benches, Crow creek. Near blooming period.
[illegible].78	33.01	6.87	50.60	Sept. 7, 1905, rich soil on river bank, Boswell ranch. Fruit.
[illegible].04	34.70	10.19	41.14	Sept. 7, 1905, rich soil among trees, river bank, Boswell ranch. Past blooming period but fruit very immature.
1.69	31.73	5.74	51.41	Sept. 8, 1905, swampy land (in water) near irrigating ditch, Boswell ranch. Too ripe. Past its prime.
[illegible].39	28.50	7.05	53.21	Aug. 30, 1905, edge of meadow, Whitehouse ranch. Fruit.
[illegible].71	31.59	9.62	47.71	July 29, 1905, in meadow, Crow creek. Bloom.
[illegible].00	28.86	6.71	50.32	Sept. 8, 1905, swampy land, Boswell ranch. Fruit. Too ripe for good hay.
1.21	40.26	7.00	43.79	July 29, 1905, dry benches, Crow creek. Bloom.
1.81	38.34	6.31	48.72	Sept. 7, 1905, sand at water's edge, Boswell ranch. In fruit and quite ripe.
[illegible].02	32.23	11.28	42.79	Aug. 12, 1905, near bank of Little Laramie.
1.11	45.35	5.61	42.86	Aug. 12, 1905, rich soil, Little Laramie. Bloom.
[illegible].41	37.89	7.57	45.73	July 29, 1905, dry benches, Crow creek. Over-ripe and not a good sample.
1.98	27.17	14.38	51.34	July 29, 1905, meadow, Crow creek. Both flowers and fruit.
[illegible].62	30.75	11.66	49.47	July 29, 1905, edge of meadow, Crow creek.
1.78	34.25	7.20	52.63	Aug. 12, 1905, gravelly soil, Little Laramie Fruit.
1.21	39.27	6.16	47.80	Aug. 12, 1905, moist soil, Little Laramie. Fruit.
1.72	38.79	6.48	46.50	July 29, 1905, dry benches, Crow creek. Bloom.
[illegible].10	23.92	23.83	38.30	Aug. 10, 1905, Experiment Farm. Second growth and not yet in bloom.
1.25	37.85	8.68	44.76	July 29, 1905, low land, Crow creek.
[illegible].11	28.87	8.29	50.69	Sept. 8, 1905, low, wet land near ditch, Boswell ranch. Fruit.
1.80	32.39	7.48	50.81	July 29, 1905, low land, Crow creek. Little past bloom.
1.78	39.74	5.00	49.66	July 29, 1905, low, wet land, Crow Creek. Bloom.
1.94	38.12	7.18	45.89	July 22, 1905, Johnson ranch, Laramie river. Near blooming period.
1.43	41.60	7.71	41.80	July 29, 1905, meadow, Crow creek. Bloom.
[illegible].41	36.76	6.86	49.42	July 29, 1905, dry benches, Crow creek. In fruit and nearly ripe.
[illegible].06	33.68	7.04	52.17	Aug. 14, 1905, moist soil, in mountains west of Centennial. Altitude about 8,500 feet. Fruit.
[illegible].07	30.59	7.71	53.76	July 29, 1905, low land, Crow creek. Bloom.
1.95	35.48	5.94	50.69	Sept. 8, 1905, river bank, Boswell ranch. Sample was in fruit and was much more coarse and rank than the above sample.
[illegible].87	26.93	15 17	49.32	July 29, 1905, meadow, Crow creek. Both flowers and fruit.
1.75	32.95	8.05	51.28	Cut in 1903 on Ernest ranch. Principally rushes and sedges.

II. *Digestion Experiments With Wethers.* The investigations along this line have been carried on during the past two years. The plants investigated thus far have been alfalfa under varying conditions and native hays. One bulletin was published during the year (Bulletin No. 69, "Digestive Experiments With Wethers, Alfalfa and Native Hay"), which includes all of the work done to date. These data bring out some very interesting features. Undoubtedly these figures show to the practical feeder that, if the best results are to be obtained, a revision in the usual feeding tables is necessary. This is brought out very nicely in the popular discussion written as a foreword to the bulletin by Prof. G. E. Morton, the Animal Husbandman, a part of which is quoted here:

TABLES OF DIGESTIBLE NUTRIENTS.

Enough analyses have been made and enough digestion experiments carried on so that tables have been prepared showing the average percentages of digestible nutrients in various feeding stuffs. Such tables may be found in any standard work on the feeding of live stock. These tables appear as follows:

NAME OF FEED	Dry matter in 100 lbs.	Digestible Nutrients in 100 lbs.			
		Protein	Carbo-hydrates	Fats	Nutritive ratio
Alfalfa	91.6	11	39.6	1.2	1:3.9

This table indicates that in feeding 100 pounds of alfalfa hay, 92 pounds of dry matter are fed, containing 52 pounds of digestible nutrients, with a nutritive ratio of 1:3.9. One thing more is necessary, however. In addition to knowing the percentages of digestible nutrients in any feed or ration, we must know the total amount in weight of these nutrients required by the animal for the most economical returns. A great many feeding experiments have been conducted with this end in view, and the results of these experiments have been embodied

in tables called Feeding Standards, which show the amount of digestible nutrients to be fed the various classes of domestic animals each day per 1,000 pounds of live weight. An example of such a feeding standard is given below:

FEEDING STANDARD FOR FARM ANIMALS.
(WOLFF-LEHMANN.)

ANIMAL	Per day per 1,000 pounds live weight				
	Dry matter	Digestible nutrients			
		Protein	Carbo-hydrates	Fats	Nutritive ratio
Fattening sheep.............	30	3.0	15.0	0.5	1:5.4

Such standards, of course, cannot be taken as absolutely accurate, because individual animals and groups of animals vary in their food requirements and because average analyses of feeds must be used, while the actual feed used will not more than approximate an average analysis. The standards, however, come very near to the needs of most animals, and a ration compounded according to the standard can easily be varied to suit the needs of the animals on feed in any particular instance, while a ration which does not approach the standard in quantity or composition will almost surely fail to produce the best results obtainable.

The error due to the use of average analyses in the compounding of rations is overcome to some extent for some Wyoming fodders in this bulletin. Analyses made at this station of some of our forage plants show that they differ markedly in composition from eastern forage plants. The experiments reported in this bulletin give new analyses and percentages of digestibility of Wyoming-grown alfalfa and native hays. By using these new results in the compounding of rations, the Wyoming ranchman will come much nearer to supplying the needs of his live stock without waste of nutrients than he could with average analyses heretofore published.

This will readily be seen from a comparison of the following tables. The first table gives a ration for a fattening lamb of 100 pounds compounded according to average analyses as compiled in Henry's "Feeds and Feeding":

RATION FOR FATTENING LAMB OF 100 POUNDS ACCORDING TO AVERAGE ANALYSES.

RATION	Dry matter	Digestible nutrients.			Nutritive ratio
		Protein	Carbo-hydrates	Fats	
Alfalfa, 2¼ lbs.	2.06	.25	.89	.03	
Corn, 1 lb.	.89	.08	.67	.04	
	2.95	.33	1.56	.07	1:5.2
Standard ration	3.0	.30	1.50	.05	1:5.4

The next table is made up with the figures for alfalfa taken from analyses and digestion coefficients of first cutting alfalfa hay, crop of 1905, as reported in this bulletin:

SAME RATION FOR FATTENING LAMB OF 100 POUNDS—WYOMING ANALYSES OF ALFALFA.

(Figures for corn taken from Henry's "Feeds and Feeding"; figures for alfalfa taken from this bulletin.)

RATION	Dry matter	Digestible nutrients			Nutritive ratio
		Protein	Carbo-hydrates	Fats	
Alfalfa, 2¼ lbs.	2.09	.28	.86	.02	
Corn, 1 lb.	.89	.08	.67	.04	
	2.98	.36	1.53	.06	1:4.7
Standard ration	3.0	.30	1.50	.05	1:5.4

The two tables above show how much error is involved in compounding by eastern feeding tables a ration containing Wyoming-grown alfalfa. If an amount of alfalfa is fed that would give a nutritive ratio of 5:2 according to eastern tables, a nutritive ratio of only 4.7 is secured.

A better balanced ration would be as follows:

REVISED RATION FOR FATTENING LAMB OF 100 POUNDS—WYOMING ANALYSES OF ALFALFA.

(See previous table for source of figures.)

RATION	Dry matter	Digestible nutrients			Nutritive ratio
		Protein	Carbo-hydrates	Fats	
Alfalfa, 1¾ lbs.	1.62	.22	.67	.01	
Corn, 1½ lbs.	1.34	.12	1.00	.06	
	2.96	.34	1.67	.07	1:5.4
Standard ration	3.0	.30	1.50	.05	1:5.4

It will be seen that this ration much more nearly approximates the standard than does the ration compounded from average analyses.

It seems necessary, then, that new feeding tables be made for the use of ranchmen in this state, and below will be found such a table for alfalfa and native hays in so far as data has been secured for them:

AVERAGE DIGESTIBLE NUTRIENTS IN WYOMING FEEDING STUFFS.

NAME OF FEED	Dry matter in 100 lbs.	Digestible nutrients in 100 pounds			Nutritive ratio
		Protein	Carbo-hydrates	Fats	
Alfalfa, first cutting	92.77	12.56	38.43	.68	3.2
Alfalfa, second cutting	93.56	12.01	42.46	.70	3.7
Mixed lowland hay*	92.90	4.58	49.41	1.33	11.5
Western Wheat Grass (irrigated)	94.20	3.81	54.01	1.09	14.9

*Water-loving species, called "native hay" elsewhere in this bulletin.

During the following year it is hoped to continue the investigations along this line, with a possibility of taking up some small grains and straw. A summary as found in Bulletin No. 69 is given below:

SUMMARY.

In Experiment I (Alfalfa, Second Cutting) each day's feces were analyzed separately, but no great variation in composition was noted.

In Expriment II (Alfalfa, Second Cutting) four different composite samples of the hay were made up and analyzed with the following results:

	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract
First	6.45	7.91	1.44	34.99	13.13	36.08
Second	5.50	7.88	1.51	33.71	14.06	37.34
Third	6.46	8.50	1.56	31.13	15.13	37.22
Fourth	6.60	8.17	1.42	33.06	14.06	36.69
Average	6.25	8.12	1.48	33.22	14.10	36.83

This shows the necessity of extreme care in sampling, if results obtained are to be relied upon, as hay from the same plot of ground varies in composition.

The average composition of the alfalfa used in the experiments given in this bulletin are as follows:

	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract
Experiment I, second cutting alfalfa, 1904	5.83	10.28	1.46	29.35	17.32	35.76
Experiment II, second cutting alfalfa, 1904	6.25	8.12	1.48	33.22	14.10	36.83
Experiment III second cutting alfalfa, 1904	6.70	8.87	1.69	27.36	15.88	39.50
AV. CROP 1904.	**6.26**	**9.09**	**1.54**	**29.98**	**15.77**	**37.36**
Experiment IX second cutting alfalfa, 1905	6.74	9.04	1.87	29.17	15.43	37.75
Experiment X, second cutting alfalfa, 1905	7.26	8.93	1.99	27.63	15.65	38.54
AV. CROP 1905.	**7.00**	**8.98**	**1.93**	**28.40**	**15.54**	**38.15**
***AV. BOTH CROPS.**	**6.44**	**8.70**	**1.62**	**30.80**	**15.08**	**37.36**
Experiment VII, first cutting alfalfa, 1905	6.47	9.12	1.81	30.83	16.09	35.68
Experiment VIII, first cutting alfalfa, 1905	8.00	9.81	2.06	28.73	16.81	34.59
AVERAGE.	**7.23**	**9.47**	**1.94**	**29.78**	**16.45**	**35.13**

*Average of eight analyses.

The average digestion coefficients as found for Wyoming alfalfa hays are as follows:

	Dry matter	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract
Exp. I, second cutting alfalfa, 1904	63.56	56.46	35.08	46.81	80.92	72.11
Exp. II, second cutting alfalfa, 1904	59.98	54.78	46.87	40.77	77.52	72.29
Exp. III, second cutting alfalfa, 1904	66.61	57.25	41.64	46.92	80.56	77.82
Exp. IX, second cutting alfalfa, 1905	66.01	53.74	43.86	50.53	78.79	76.71
Exp. X second cutting alfalfa, 1905	66.30	54.51	49.13	46.12	80.35	78.69
Exp. VII, first cutting alfalfa, 1905	58.45	45.70	32:71	40.57	74.83	71.07
Exp. VIII, first cutting alfalfa, 1905	62.33	45.96	37.86	48.16	77.83	72.52
AVERAGE (second cutting, 1904)	**63.39**	**56.17**	**41.20**	**44.84**	**79.67**	**74.08**
AVERAGE (second cutting, 1905)	**66.16**	**54.13**	**46.50**	**48.32**	**79.57**	**77.70**
AVERAGE (second cutting, all experiments)	**64.50**	**55.35**	**43.32**	**46:23**	**79.63**	**75.58**
AVERAGE (first cutting, 1905)	**60.39**	**45.85**	**35.29**	**44.37**	**76.33**	**71.80**

Wyoming alfalfa hay runs higher in crude fiber and crude protein than the average. The digestion coefficients of the crude protein is also high. The nutritive ratio of first cutting alfalfa is 1:3.19; second cutting for both years, 1:3.68. Second cutting alfalfa is apparently a better feed.

The native hays gave the following composition:

	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract
Exp. IV, Western Wheat Grass	5.94	6.23	2.68	29.48	6.85	48.82
Exp. V, Western Wheat Grass	5.51	6.27	2.52	29.78	6.63	49.29
Exp. VI, native hay (mixed sedges, rushes, grasses)*	7.10	6.42	2.11	28.91	7.75	47.71

The digestion coefficients were found as follows:

	Dry matter	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract
Exp. IV, native hay (one sheep)	63.50	31.35	40.79	67.26	58.77	67.20
Exp. V, native hay	65.21	30.27	41.98	71.31	55.00	68.46
Average (three sheep)	64.64	30.63	41.59	69.96	56.26	68.04
Exp. VI, native hay (sedges, rushes, grasses)*	63.21	53.04	62.87	65.09	59.06	64.12

*See Bulletin 69, "Digestion Experiments with Wethers." This station.

The native hays of Wyoming are better and more nutritious than timothy grown in the eastern states.

The digestible nutrients in 100 pounds of hay are given below calculated from the experiments described in this bulletin:

DIGESTIBLE NUTRIENTS IN 100 POUNDS OF AIR-DRIED MATERIAL AND NUTRITIVE RATIO.

	Dry matter	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	Nutritive ratio
Alfalfa, first cutting, 1905	56.02	0.68	13.21	12.56	25.22	1: 3.19
Alfalfa, second cutting, 1905	61.53	0.90	13.72	12.37	29.64	1: 3.68
" " " 1904-5	60.35	0.70	14.24	12.01	28.22	1: 3.68
Western Wheat Grass, 1904	60.89	1.09	20.69	3.81	33.32	1:14.86
Native hay, 1904	58.73	1.33	18.82	4.58	30.59	1:11.48

The water soluble material was determined in the alfalfa and native hays with the following results:

	Total water extract	Ash	Total organic matter
Alfalfa, average	27.43	5.93	21.50
Western Wheat Grass	22.23	2.58	19.65
Native hay	18.84	3.79	15.05

Alfalfa gives a larger water soluble extract than either Western Wheat Grass or native hay. This may in part account for the fact that the alfalfa is more susceptible to fermentation and decay upon dampening during the process of curing than the other hays experimented with. As is well known, it blackens oftentimes after a heavy dew.

III. *Alkali Studies.* This is a continuation of the investigations carried on at this station for a number of years past, a number of bulletins having already been published upon varying phases of the subject.*

The alkali studies embodied in this report† have been carried on intermittently for the past three years. The work was begun primarily to determine if mixtures of salts in solution had any effect upon water absorption by seeds other that that which simple salt solutions produce. The results

*Bulletin 29, "Alkali: Some Observations and Experiments," Buffum; Bulletin No. 39, "Alkali Studies No. II," Slosson and Buffum; "Alkali Studies III," Buffum; Ninth Annual Report of this Station; and "Alkali Studies V," Buffum and Slosson; Tenth Annual Report of this Station.

†See "Alkali Studies VI" in another portion of this report.

were so varying that the problem was discontinued and the effect upon salt absorption was tried. We were unfortunate in not having a thermostat adequate for the purpose of keeping constant temperatures, and that may account for some of the variations in different series, but an attempt was made to run all the experiments of each separate series under the same conditions.

IV. *Miscellaneous.* Under this head are classed analyses of samples sent in by interested parties, which occasionally takes a large share of the time of the staff in this department. It is the practice to make analyses and investigations, free of charge, as time will permit, for interested parties, when it is believed that the interest is more than local, or if it is thought that the data will be of value for guidance in future work.

ALKALI VI.

HENRY G. KNIGHT AND ROSS B. MOUDY.

The papers giving results of alkali investigations which have been published heretofore by the station are "Alkali," Bulletin No. 29; "Alkali Studies II," Bulletin No. 39; "Alkali Studies III"; "Alkali Studies IV"; "Alkali Studies V," and "Alkali Lakes and Deposits," Bulletin No. 49. Alkali Studies III and Alkali Studies IV are a part of the ninth annual report, and Alkali Studies V is a part of the tenth annual report.

The investigations given in this paper were begun by Dr. E. E. Slosson while he was Chemist of this station. The work has been continued along the same lines, and free use has been made of his results and his notes.

These investigations were taken up to determine what effect the presence of ions of different velocity had upon the absorption of a given salt by seeds and incidentally to determine if ionic velocities had any marked effect upon salt absorption. It was hoped that this would throw some light upon the apparent selective salt absorption which at one time was thought

to be purely a biological process. Recent investigations have, however, tended to show that ionic mobility does have some effect upon salt absorption, and that, roughly, at least, salts are absorbed in a direct ratio of the velocity in which they diffuse through water.*

It has been noted that some salts are absorbed by seeds to a much greater extent than others under originally the same "head" of osmotic pressure.*

The number of molecules of different salts absorbed by weight. Since ions diffuse more rapidly than molecules,‡ if for the number of molecules forced through water in a given length of time by osmotic pressure.

Other experiments have been carried out in this laboratory with solutions of different salts of osmotic pressure of ten and twenty atmospheres. Dividing the amount of salt absorbed per hundred weight of dry seed by the equivalent weights gives the relative number of molecules forced into the seeds in a given length of time, and may be compared with the number of molecules forced through water in a given time by osmotic pressure, as discovered by Long.

	No. molecules diffused through water	No. molecules absorbed by corn. 10 atmospheres†	No. molecules absorbed by wheat. 20 atmospheres‡
Sodium sulphate	.678	90	122
Sodium chloride	.600	60	96
Potassium sulphate	—	142	182
Potassium chloride	.808	109	128

†Soaked 116 hours.
‡Soaked 72 hours.

It appears that salts under the same osmotic pressure are absorbed by seeds in the order of their diffusibility. The ratio is not the same, but that could not be expected under the crude conditions of the experiments in which the motive force was constantly changing. These figures compare favorably with those found by Slosson.§

*"Alkali Studies IV," Ninth Annual Report of Wyoming Experiment Station.
**Ostwald: Lehrbuch der Allgemeinen Chemie, I, 691.
§"Alkali Studies IV," Ninth Annual Report of this Station.

METHOD OF CONDUCTING EXPERIMENTS.

The osmotic pressures were calculated from the formula*

$$P=\frac{.0819T}{V}\left(\frac{c(n-1)}{1-C}\right)$$

in which P is the osmotic pressure in atmosphere, T is the absolute temperature, V is the volume in liters which contain one gram molecule of the salt, c is the electrical conductivity of the solution, C is the electrical conductivity at infinite dilution† and n is the number of ions into which the molecule dissociates.

To get the osmotic pressure as nearly exact as possible, osmotic pressure curves were plotted for each salt. After solutions were made up they were standardized carefully. About ten grams of selected seeds were placed in salt-mouth bottles along with 200 cubic centimeters of standard salt solutions and the bottles tightly stoppered with glass stoppers. The solutions were changed every twenty-four hours. In experiments where it was wished to determine the effect of rapid or slow moving ions upon salt absorption, solutions were made up of the required ion-giving substances of osmotic pressure corresponding to the osmotic pressure of the solution with which it was to be used. One cubic centimeter of the ion-giving substance was added to every 200 cubic centimeters of the stock solution. The amount of added substance was made as small as possible, so that the change in ionization would be inappreciable.

The calculations are made upon a basis of ten grams of seeds. The number of molecules upon a basis of one hundred seeds are in the same direction as the results obtained by Long** anything will effect the diffusibility of the ions, the results should be easily shown by experiment with the absorption of

*Nernst: Theoretical Chemistry, p. 137.
†The conductivities were taken from Smithsonian Physical Tables, pp. 260-261, and Ostwald: Lehrbuch der Allgemeinen Chemie, II, 1, p. 723.
‡Nernst, 326.

salts by seeds. Ions which move rapidly are accelerated in the presence of ions which move slowly. The reverse is also true. Ions which move slowly are retarded in the presence of ions which move rapidly, both relatively and absolutely.†

The following calculations have been made for the relative velocity of various ions‡ at a dilution of 1,000 liters from their conductivities:

Natrion	=41.1	Hydroxidion	=154.3
Kalion	=59.7	Hydrion	=285.5
Chloridion	=59.7	½ Sulphanion	= 61.0
Calcion	=39.3§		

The above figures also correspond to the rapidity with which the various ions will be forced through water by osmotic pressure, as determined by Long.**

For example, kalion should diffuse more rapidly in the presence of natrion and the natrion should be retarded. Applying this to absorption of salts by seeds in the presence of sodium salts, potassium salts should be absorbed in the greater abundance, *i. e.*, absorption of salts takes place along the lines of least resistance.

To test the theories as given above, experiments were tried with various salt solutions upon corn and wheat. It was found that where pure water was used there was a leaching out of the salt, as would be expected. This varied with the seeds used, with the time of soaking and temperature. Below is the tabulation of results:

	Corn	Corn	Wheat	Wheat	Wheat
Per cent of ash in original seed........	1.59	1.77	1.72	1.72	1.72
Per cent lost soaked in pure water.....	.40	.23	.11	.28	.15
Time of soaking in hours..............	144	116	72	96	72

The ash was determined upon one sample of wheat, and that taken as the average amount of ash present in the wheat

†Ostwald, 695.
‡Ostwald: Outlines of General Chemistry, 281-284.
§Ostwald, II, 1, 757.
**Ostwald: Lehrbuch der Allgemeinen Chemie, I, 691.

used. It was all selected wheat from the same lot. The corn was taken from two different lots.

The table below gives the gain in ash after soaking wheat and corn in various simple salt solutions of osmotic pressure of ten and twenty atmospheres:

	Corn,* 10 at.	Relative No. of molecules	Wheat,† 20 at.	Relative No. of molecules
KCl	.81%	109	.94%	126
½ K_2SO_4	1.24	142	1.81	208
NaCl	.35	60	.59	101
½ Na_2SO_4	.66	94	.80	112

It will be noted that the salts are absorbed in the order of their diffusibility, although the ratio is not the same. This would not be expected under the crude conditions of the experiments.

*Soaked 116 hours.
†Soaked 96 hours.

The table below gives relative figures for the effect produced by the addition of hydroxidion to solutions of various salts:

GAIN IN ASH.

	Corn,* 10 at.	Relative No. of molecules	Wheat,† 20 at.	Relative No. of molecules
KCl	.81%	109	.94%	126
KCl+KOH	.58	78	.91	122
½ K_2SO_4	1.24	142	1.81	208
½ K_2SO_4+KOH	.58	66	1.41	162
NaCl	.35	60	.59	101
NaCl+NaOH	.29	50	.56	96
½ Na_2SO_4	.66	94	.80	112
½ Na_2SO_4+NaOH	.36	50	.82	116

*Soaked 116 hours.
†Soaked 96 hours.

It will be noted that in every case, with the exception of sodium sulphate with sodium hydroxide at twenty atmospheres, the addition of the extreme rapid moving hydroxidion to the slow moving negative ions retards absorption of salts. Absorption of sodium sulphate in the presence of sodium hy-

droxide seemed to work backwards to what would be expected. This was noted and several experiments were tried to determine if this was accidental or not. The table below gives the results:

GAIN IN ASH.

	Corn,* 20 at.	Rel. No. mol.	Corn,† 10 at.	Rel. No. mol.	Wheat,‡ 10 at.	Rel. No. mol.	Wheat,§ 20 at.	Rel. No. mol.
½ Na_2SO_4	1.09%	144	.66%	94	.05%	8	.34%	42
½ Na_2SO_4+NaOH	2.04	286	.36	50	.27†	38	.38	54
½ Na_2SO_4					.80**	112	.76††	106
½ Na_2SO_4+NaOH					.82	116	.84	118
½ Na_2SO_4					.86‡‡	122		
½ Na_2SO_4+NaOH					.90	126		

*Soaked 144 hours.
†Soaked 116 hours.
‡Soaked 72 hours.
§Soaked 144 hours.
**Soaked 96 hours.
††Soaked 96 hours.
‡‡Soaked 72 hours.

These results make it appear as though sodium sulphate was accelerated in the presence of sodium hydroxide. No reason can be given for this, as it is directly opposite to what would be expected. The following table gives the effect of the addition of the extremely rapid hydrion to solutions of salts:

GAIN IN ASH.

	Corn,* 10 at.	Relative No. of molecules	Wheat,† 20 at.	Relative No. of molecules
KCl	.81%	109	.94%	126
KCl+HCl	.50	67	.54	73
½ K_2SO_4	1.24	142	1.81	208
½ $K_2SO_4+H_2SO_4$	.83	96	1.66	190
NaCl	.35	60	.59	101
NaCl+HCl	.22	38	.55	94
½ Na_2SO_4	.66	94	.80	112
½ $Na_2SO_4+H_2SO_4$	.28	40	.78	110

*Soaked 116 hours.
†Soaked 96 hours.

In every case the addition of the rapid hydrion to salts has decreased the absorption of that salt by the seed, which is in direct accord with the theory.

To determine the effect of slow moving ions upon the absorption of rapid moving ions, calcion was chosen as the slow moving ion. The results were not entirely satisfactory, and

the velocity of the calcion being too near that of the other ions is given as a probable cause.

INCREASE OF ASH.

	Corn,* osmotic pressure 20 at.	Relative No. of molecules
NaCl	.95%	162
$NaCl+CaCl_2$	.98	167
KCl	2.10	282
$KCl+CaCl_2$	2.17	291
Na_2SO_4	1.09	77
$Na_2SO_4+CaSO_4$	1.55	109
K_2SO_4	2.70	(?) 155
$K_2SO_4+CaSO_4$	2.20	(?) 127

*Soaked 144 hours.

The slower calcium ion increases the absorption in most cases, although the difference is not great. Calcium sulphate is but slightly soluble and it was impossible to get the required amount in solution. Several experiments were conducted with potassium sulphate containing calcion, but the results were far from satisfactory and so are not given here.

SUMMARY.

(1) In pure water seeds lose a portion of the original salt.

(2) Absorption of salts by seeds from solutions of same osmotic pressure corresponds favorably with the numbers obtained by Long, for the number of molecules forced through water in a given length of time.

(3) The absorption of salts by seeds is in a direct ratio with the relative mobility of the ions. This is not exactly so, nor would it be expected to be under the crude conditions of the experiments.

(4) The addition of a more rapid ion, whether positive or negative, in small quantities to solutions of slower ions retard absorption of the slower ion.

(5) The experiments in which slow positive calcion was added to rapidly moving ions was not very satisfactory, but results indicate that slow moving calcium tends to increase absorption slightly.

Report of the Botanist.

The Botanist can scarcely be said to have been on duty during the year 1905-06. Though in continuous supervision of the work of his department in the University and College, yet he was excused during that time from most of the work of the class-room. Similarly in the station the work was largely suspended during his (nominal) leave of absence. However, this statement applies only to the research work. All of the routine work had as careful attention as ever in the past.

When a station department has been established for a series of years, certain mutually helpful relationships grow up between it and similar departments elsewhere. The maintenance of such relationship necessitates a certain amount of correspondence. The longer a department is in operation, the larger is the number of citizens that come to look to it for information along certain lines. It has happened, therefore, that no inconsiderable amount of time has been consumed in routine work that could not well be put aside—work that, from the standpoint of the inquirer, is just as vital as the solution of heretofore unanswered problems.

Other work, however, was not wholly eliminated, this department co-operating with that of Chemistry in the preparation of Bulletin No. 70, "Wyoming Forage Plants, and Their Chemical Composition—Studies No. 2," technical and popular descriptions of the plants considered in it being prepared by the Botanist.

A few short articles and items were contributed to various publications, and one or two technical papers on the flora of the State have also appeared.

The following outline of work planned for the year 1906-07, approved by the Station Council, is here appended.

It is not expected that all of these will be taken up, but choice will be made from among them as conditions and facilities for work seem to make them desirable.

FUNGOUS DISEASES OF THE AGRICULTURAL CROPS—

(1) The fungous diseases of Wyoming orchards.

(2) Alfalfa Leaf-spot disease: its history, cause, protective measures, etc.

(3) The Root-gall disease of the Cottonwood and other shade trees.

PLANT BREEDING—

With a view to securing—

(1) A perennial alkali-resistant forage plant; seed selection. The following to be used as the basis of experiments: (a) Melilotus alba, (b) Scirpus tuberosus, (c) Astragalus Bodini, (d) Vicia linearis and V. cæspitosa, (e) Hedysarum pabulare, (f) Others as their availability becomes apparent.

(2) A perennial shrubby aster, to replace the Shasta daisy in high altitudes, using Xylorrhiza Parryi as the original; seed selection, vegetative propagation, and cultural advantages.

(3) Experiments with Sporobolus brevifolius as a lawn grass.

Report of the Irrigation Engineer.

HERBERT T. NOWELL.

The time of the Irrigation Engineer was so largely taken up by instruction work in other departments, as well as his own, that no opportunity was had for research work in Agriculture. Lectures on irrigation subjects were given at the Farmers' Institutes at Wheatland and Grand Encampment. Several short articles were written for *The Ranchman's Reminder*, and material prepared for a pamphlet on small reservoirs.

PLANS FOR NEXT YEAR.

The work in teaching has been adjusted so that the Irrigation Engineer will be able to give almost his whole time to experimental investigations. Three lines of work are planned, the first in soil moisture investigations at the Cheyenne Dry Farm, in co-operation with the Department of Chemistry; the second in duty of water determinations and records at the Experiment Farm; the third in drainage investigations at the old penitentiary farm.

Plans of Work.

DEPARTMENT OF AGRICULTURE.
1906-07.

I. Agronomy—
- a. Barley (new investigations), wheat, oats, spelt, rye and flax for seed and feed.
- b. Field pease—varieties—for feeding experiments.
- c. Forage crops—alfalfa, sweet clover.
- d. The nitrogen problem.
- e. The pasture problem.
- f. Management of soils. Dry farming—reclamation.

II. Animal Husbandry—
- a. Ration experiments.
- b. Digestion experiments.
- c. Breeding experiments.
- d. Poultry experiments.
- e. Wool investigations.
- f. Data and records.

III. Horticulture—
- a. Fruits at Lander.
- b. Vegetables at Laramie.

IV. Irrigation—
1. Irrigation practice—
   - a. Duty of water.
   - b. Amount of water used by the crops.
2. Reclamation—
   - a. Drainage.
   - b. Alkali.
3. Dry farming.

V. Miscellaneous Work—
- a. Publications.
- b. Records.
- c. Farmers' Institutes and Short Courses.
- d. Propaganda and correspondence.

PLANS OF WORK

DEPARTMENT OF CHEMISTRY.
1906-07.

1. Digestion experiments in conjunction with Animal Husbandry Department:

   A. Hays—
   - (a) Hay grasses.
   - (b) Sedges (principal ones), Juncus, etc.
   - (c) Rushes.
   - (d) Straw, Oat and Barley, etc.

   B. Grains—
   - (a) Barley.
   - (b) Spelt.

2. Forage investigations. Continuation of work of 1904-06 with native forage.

3. Alkali studies.

4. Milk investigations:
   - (a) Effect of time of milking upon fat, and total solids.
   - (b) Difference in night and morning milk.
   - (c) Effect of Wyoming feeds (different kinds).

Meteorological Report

FOR THE YEAR ENDING DECEMBER 31, 1905.

FRANK SMITH, OBSERVER.

The work for this year has been a continuation of the work that has been carried on for the last fifteen years.

Observations are taken at 7 a. m. and 7 p. m. each day, and a full record kept.

A report is made out each week during the crop-growing season and sent to the Section Director of the Weather Bureau at Cheyenne. This report consists of maximum and minimum temperatures, per cent of sunshine, rainfall, and unusual phenomena, as hail, excessive rain, high winds, thunder storms, draughts, lightning, etc.

A monthly report of two carbon copies is made out on the last day of each month and sent to the Section Director of the U. S. Weather Bureau. This report contains observations of each day's maximum, minimum, mean, range, precipitation (rain or snow), character of day (clear day, partly clear, cloudy), prevailing winds, direction, and any uncommon occurrences.

The original records are carefully compiled and kept at the office for future inspection.

The instruments used are the same as used at all Weather Bureau Stations. They consist of a barometer, which is a standard observatory instrument, 45 inches high, reading to .001 of an inch, with an attached thermometer; a barograph, or self-registering aneroid barometer, which gives a continuous record of atmospheric pressure on a sheet of paper, which is graduated, this paper being changed once a week; a maximum and a minimum, which are set each day at 7 p. m. and 7 a. m.,

respectively; a phychrometer, consisting of two mercurial thermometers attached to a metalic frame, so arranged that one thermometer sets lower than the other, and this one has a small piece of cloth wound around the bulb, so that it may be moistened before using. The difference between the wet and dry bulbs reading compared with dry bulb reading gives dew point, relative humidity, and vapor pressure. An evaporation tank, being a tank, one meter cube, which is filled with water, and readings are taken by a hook guage, which is graduated to read to .001 of a foot. It is read every evening at 7 p. m. through the year, when the water is not frozen.

Draper's self-registering dial is a thermometer which gives a continuous reading of the temperature on a disk sheet of paper, which is changed once a week.

Ground or soil thermometers, of which there are six placed vertically in the ground to the depth of 3, 6, 12, 24, 36, and 72 inches, respectively, give the temperature of the ground at those depths.

A Rain Guage. Precipitation is measured in a cylinder guage. The outer cylinder, in which the precipitation is received, is just ten times as large as the one which receives the water for measurement. When there is less than .01 inch of rain, it is designated by T, which means merely a trace.

Sunshine Recorder. Clouds are estimated from sheets of blue print paper, which are placed in half cylinders, and through an opening the sun's rays are exposed to the paper in such a manner as to cause a streak across it. The per cent is estimated by measurement. The days are known as clear, partly clear, and cloudy.

Wind. The machine used is Frieze's quadruple register. with Robinson's anemometer. The anemometer is located on a tower about 70 feet from the ground, and 100 yards from the

buildings. It is connected with the register, which is in the office on the main floor of the main building, by wires which carry a current of electricity which works the armatures of the register, giving the velocity and direction of the wind, on a specially prepared sheet of paper. This is changed each noon, and the wind record worked out for the last twenty-four hours.

SUMMARY FOR THE YEAR 1905.

Highest temperature	91°,	July 13
Lowest temperature	—42°.	February 12
Greatest daily range	48°.	September 22
Lowest daily range	7°,	November 5
Highest barometer	23.395,	December 9
Lowest barometer	22.507,	November 27
Mean	23.069	
Prevailing wind, direction, southwest.		
Greatest precipitation in 24 hours	.85,	September 29
Highest monthly precipitation	1.79,	May & June
Least monthly precipitation	.03,	December
Total precipitation for year	9.76	

SUMMARY OF 1905 BY MONTHS.

	Max.			Min.			Mean Temp.	Range			Precipitation	Snow fall	Day			Barometer			Prevailing Wind. Dir.
	Highest	Lowest	Mean	Highest	Lowest	Mean		Greatest	Lowest	Average			Clear	P. Clear	Cloudy	Highest	Lowest	Average	
January	47	0	33.6	30	-24	12.5	22.7	44	9	21.8	.30	4.70	10	11	10	23.256	22.760	23.028	SW
February	52	-5	28.3	25	-42	2.3	15.4	45	10	26.7	.42	4.20	16	10	2	23.277	22.647	22.951	S
March	57	32	45.3	35	4	24.0	34.5	34	8	21.4	.64	5.10	14	10	7	23.245	22.575	22.930	W
April	67	26	47.2	38	0	24.1	34.3	38	8	22.5	1.21	12.80	11	9	10	23.115	22.750	22.943	W
May	72	35	56.1	44	20	33.2	44.7	36	14	22.9	1.79	6.80	13	14	4	23.213	22.608	22.943	W
June	83	57	70.4	54	34	40.3	58.3	44	15	38.0	.36	0	21	9	0	23.138	22.887	23.069	SE
July	91	52	76.4	58	33	46.0	61.4	43	9	30.7	1.79	0	4	27	0	23.319	22.938	23.193	NE
August	90	60	79.1	59	40	46.8	62.1	43	11	32.0	.83	0	19	12	0	23.391	23.081	23.225	SE
September	81	44	70.1	48	31	38.4	54.9	48	11	32.8	1.62	0	13	11	6	23.291	22.763	23.101	W
October	78	23	50.5	39	-8.5	24.3	37.4	42	8	26.2	.46	3.25	13	11	7	23.234	22.782	23.081	SW
November	61	25	46.6	32	5	19.4	32.9	43	7	27.2	.22	2.50	15	14	1	23.310	22.507	23.342	SW
December	56	10	34.5	30	-5	10.0	22.4	44	10	24.0	.03	.40	22	7	2	23.395	22.711	23.017	SW
Average			52.4			26.8	40.1			27.4	9.76	39.75	171	145	49			23.069	

TEMPERATURE (MEAN)—LARAMIE, WYO.

YEAR	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct	Nov.	Dec.	Mean
1891	20.2	23.3	25.6	40.5	54.5	58.4	61.2	61.1	55.1	43.2	28.6	19.6	40.9
1892	20.6	25.2	30.8	35.5	44.4	55.7	62.8	61.9	56.0	39.2	33.1	20.7	40.5
1893	26.8	20.7	28.8	34.2	44.2	57.2	64.0	60.7	52.8	42.3	29.2	26.6	40.6
1894	19.9	16.2	29.4	39.1	52.3	55.8	63.2	62.2	51.8	44.4	22.8	21.5	39.9
1895	20.5	17.9	27.5	40.0	45.3	52.2	58.8	61.6	54.5	40.9	27.0	15.3	38.5
1896	27.7	22.8	26.2	37.4	47.3	59.1	62.3	61.9	52.6	41.9	26.3	31.4	41.4
1897	16.5	21.2	24.3	35.0	49.3	58.9	60.7	60.5	56.6	42.3	34.8	15.0	39.6
1898	17.0	25.5	26.8	40.3	44.1	56.8	65.1	62.9	51.9	39.3	23.1	14.3	38.9
1899	20.6	9.5	24.5	38.3	45.5	55.8	62.1	67.0	59.7	40.8	35.7	17.2	38.8
1900	25.7	19.7	32.2	35.9	50.8	61.5	62.8	62.3	51.8	45.1	38.5	25.7	42.6
1901	19.3	19.4	26.5	34.5	49.5	53.6	67.8	62.7	52.4	44.4	31.8	20.9	40.2
1902	22.2	26.2	27.5	37.6	49.0	58.0	59.9	57.4	51.5	44.3	32.6	24.5	40.9
1903	23.3	11.5	20.3	37.5	43.9	53.9	62.7	63.1	51.2	43.3	34.8	26.4	40.1
1904	20.2	29.7	32.5	38.5	46.8	54.0	60.5	61.5	54.3	42.2	35.5	26.2	41.8
1905	23.1	15.5	34.6	35.6	44.6	58.3	61.4	62.9	54.9	37.4	33.0	22.2	40.3
Mean	21.6	20.3	28.4	37.3	47.4	56.6	62.3	61.9	53.8	42.1	31.1	21.8	40.33

PRECIPITATION.

YEAR	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1891	0.70	0.38	1.50	0.25	2.92	0.91	1.20	1.76	1.80	0.30	1.09	1.11	13.92
1892	0.01	0.36	0.52	0.19	1.16	3.97	2.22	0.14	T	3.96	T	0.20	12.73
1893	T	0.11	0.29	0.32	0.33	0.54	0.34	1.08	0.39	0.28	0.06	0.10	3.84
1894	0.03	0.10	0.29	1.51	0.42	0.64	1.41	1.26	1.60	0.09	0.05	0.23	7.63
1895	0.08	0.14	0.43	0.87	2.09	2.12	2.71	1.17	0.18	0.74	0.32	0.33	11.15
1896	0.44	0.17	0.59	3.53	2.37	1.72	1.66	0.89	1.16	0.18	0.09	T	12.80
1897	0.39	0.35	4.23	0.55	1.85	0.72	1.29	1.11	0.32	0.55	0.33	0.77	12.48
1898	0.05	0.01	0.40	1.26	1.88	0.90	0.65	1.16	T	0.48	0.61	0.23	7.63
1899	0.95	1.13	1.11	1.75	0.37	1.11	2.01	1.43	0.17	1.13	0.07	0.61	11.84
1900	0.01	0.82	0.58	2.91	0.24	0.35	1.25	0.61	1.11	0.56	0.06	0.03	8.53
1901	0.04	0.41	0.05	0.28	3.00	1.73	0.32	1.11	0.09	1.28	T	0.21	8.52
1902	T	0.26	0.41	0.88	0.26	0.60	1.49	0.40	1.58	0.74	0.22	0.89	7.73
1903	0.11	0.36	1.09	0.73	1.63	1.00	1.31	0.88	2.39	0.50	0.30	0.07	10.37
1904	0.25	0.11	0.36	0.84	1.74	2.01	1.33	0.93	1.35	0.54	0.04	0.08	9.58
1905	0.30	0.42	0.04	1.21	1.79	0.36	1.79	0.83	1.62	0.46	0.22	0.03	9.76
Mean	0.23	0.34	0.83	1.14	1.47	1.24	1.40	0.99	0.92	0.79	0.22	0.33	9.90

APPENDIX

A Classification of Agricultural Literature.

BY G. E. MORTON.

Designed primarily for the use of Animal Husbandmen in indexing card catalogues of information, clipping files, and private libraries.

It includes all branches of agriculture—each branch being developed to a greater or less degree—and related subjects as given in the Dewey Decimal System. The classification is based upon the Dewey System, except heading 632, which is here changed from Pests, Hindrances, etc., to Plants, Horticulture. The reason for this change is that in the Dewey System no place is provided for works on general horticulture, while pests and hindrances naturally fall under plant pathology, veterinary science, and entomology. The author does not lay claim to training in library science and no doubt many errors and omissions will be evident. The classification is advanced simply as one which has proved itself better suited to the needs of the author's private library than any previously existing classification known to him. It is far too detailed in Animal Husbandry for the needs of the general library, but it will furnish a ready means of classifying any literature that a specialist in animal husbandry may find it necessary to collect. I acknowledge my indebtedness to Mr. W. P. Cutter and Mr. J. I. Wyer, from whose classifications I have borrowed much;* and to others whose assistance I have received.

The headings for soils and for field, garden, and fruit crops are taken chiefly from Mr. Cutter's classification.

*Cutter Classification, Bulletin 65, Office of Experiment Stations. Wyer Classification, 13th Annual Report of the U. S Agricultural Experiment Station of Nebraska.

An asterisk preceding a number denotes a deviation from, or extension of the Dewey classification, and applies to all subdivisions.

The following directions will be found helpful in classifying clippings by the vertical file system:

Put sub-headings classified by whole numbers such as 330, 540, 630, etc., upon index sheets having tab in middle.

Put sub-headings classified by whole numbers such as 336, 542, 636, etc., upon index sheets having tab (cut ½) on left.

Put sub-headings classified by numbers with one figure in the decimal upon index sheets having tab (cut ½) on right.

Put sub-headings classified by numbers of more than one figure in the decimal upon index sheets having tabs cut ⅓ or ¼ or ⅕, if necessary.

Put sub-headings which it is not desirable to sub-divide further, upon envelopes distributed behind the proper index sheets.

The proper classification number must accompany each heading, and subheading; and when a clipping is filed in an envelope the envelope number should be put upon the clipping. This provides for the clipping being replaced in the envelope after being removed, without the necessity of consulting the classification index. Until the user of the classification becomes familiar with it, frequent reference to the index will be necessary, but the order of the sections most frequently used will soon become familiar, and the classification can be used direct without reference to the index.

Where letters are used in connection with numbers, enclose the letter in a circle, in order that it may not be mistaken for a numerical figure, thus, 636.12(H), Breeds of Horses.

CLASSIFICATION.

330. POLITICAL ECONOMY.

333. LAND. OWNERSHIP, RIGHTS, AND RENT:
.5 Rent of Land for Cultivation.
.7 Forests (rental).

336. FINANCE:
.1 State Domain and Properties.
.2 Taxation—
.21 *Direct.*
.22 *Indirect.*

337. PROTECTION AND FREE TRADE:
.5 Duties on Special Articles, Wool, etc.

338. PRODUCTION, MANUFACTURES, PRICES:
.1 Agricultural Products.

530. PHYSICS.

540. CHEMISTRY.

550. GEOLOGY.

551. PHYSICAL AND DYNAMICAL:
.5 Meteorology.

560.

570. BIOLOGY.

575. EVOLUTION:
.1 Heredity—
.19 *Atavism.*
.2 Variation.
.3 Environment.
.4 Natural Selection.
.5 Sexual Selection.
.6 Development. Survival of Fittest.
.7 Degeneration.
.8 Origin of Species.
.9 Origin of Sexes.

580. BOTANY.

581. PHYSIOLOGICAL AND STRUCTURAL:

.1 Physiology.

.2 Pathology—

.21 *Diseases.*

.22 *Teratology.*

.23 *Parasites.*

589.95 BACTERIOLOGY.

590. ZOOLOGY.

591. PHYSIOLOGICAL ZOOLOGY.

.1 Physiology—

.11 *Circulation.*

.12 *Respiration.*

.13 *Nutrition.*

.14 *Secretion and Excretion.*

.15 *Variation.*

.16 *Generation.*

.17 *Histogenesis.*

.18 *Nervous Functions and Sensations.*

.19 *Physiological Chemistry.*

.3 Embryology—

.33 *Development of Embryo.*

.34 *Metamorphosis, Larva, Pupa, Moulting.*

.35 *Hyper-metamorphosis.*

.36 *Production of Sexes.*

.4 Morphology, Comparative Anatomy.

.5 Habits and Behavior—

.56 *Philoprogenitiveness. Breeding.*

.7 Organography, Descriptive Anatomy.

595.7 Entomology.

598.2 Ornithology.

599. MAMMALS, MAMMALIA:

.7 Ungulata, Carnivora, Domestic Animals.

610. MEDICINE.

*619. COMPARATIVE MEDICINE: VETERINARY SCIENCE:

.001 Bibliography.
.002 Compends.
.003 Dictionaries, Encyclopædias, etc.
.004 Essays, Lectures, Addresses.
.005 Periodicals.
.006 Societies.
.007 Study and Teaching—
.0071 *Veterinary Schools.*
.0072 *Veterinary Museums.*
.008 Official Publications.
.0091 History.
.0092 Legislation.
.0093 Statistics.

.01 ANATOMY, HISTOLOGY—
(For sub-divisions of this and following headings, *see* corresponding headings under 610, Medicine, Dewey Decimal System.)
.011 Circulatory System.
.012 Respiratory System.
.013 Digestive System.
.014 Glandular and Lymphatic.
.015
.016 Genito-Urinal System.
.017 Motory and Integumentary System.
.018 Nervous System.
.019 Regional Anatomy.

.02 PHYSIOLOGY—
(May be sub-divided like 619, if desired.)
.021 Blood and Circulation.
.022 Respiration.
.023 Digestion, Absorption, Nutrition—
.0232 *Nutriments.*
.0233 *Stimulants, Condiments.*

.024 Secretion and Excretion.

.025 Animal Heat.

.03 HYGIENE.

.04 HEALTH AND PROTECTION OF DOMESTIC ANIMALS (PUBLIC MEASURES, ETC.).

.05 MATERIA MEDICA AND THERAPEUTICS.

.06 PATHOLOGY, DISEASES, TREATMENT.

.07 SURGERY.

.08 FEMALE DISEASES, OBSTETRICS.

.1 H, Horses; A, Asses; M, Mules.

(Sub-divide this and following with o divisions as above, if necessary.)

.2 Cattle.

.3 S, Sheep; G, Goats.

.4 Swine.

.5 Poultry.

.6 Birds.

.7 Dogs.

.8 Cats.

.9 Other Animals.

620. ENGINEERING.

621. MECHANICAL.

624. BRIDGES AND ROOFS.

625. RAILROAD AND ROAD.

626. CANAL ENGINEERING.

.8 Irrigation Canals, and other Irrigation Works.

627.5 DRAINAGE.

628. SANITARY:

.6 House Drainage.

.7 Rural Water Supply, Villages and Country Homes.

.8 Ventilation and Heating.

.9 Lighting.

629. OTHER BRANCHES:

.1 Agricultural.

*630. AGRICULTURE.

.001 Bibliography.

.002 Compends.

.003 Dictionaries, Encyclopædias.

.004 Essays, Lectures, Addresses.

.005 Periodicals.

.006 Societies.

.007 Study and Teaching—

.0071 *Elementary Schools.*

.0072 *Secondary Schools.*

.0073 *Colleges.*

.0074 *Teachers' Institutes and Summer Schools.*

.0075 *Chautauquas.*

.0076 *Farmers' Institutes and Short Courses.*

.008 Official Publications, Reports, etc.

.0091 History.

.0092 Legislation.

.0093 Statistics.

.1 Rural Life.

.2 Economics—(*See also* 330)—

.21 FARM MANAGEMENT—

.211 Laying out Farm—

.2111 *Fields.*

.2112 *Farmsteads.*

.2113 *Roads and Lanes.*

.212 Rotation of Crops.
.213 Mixed Husbandry.
.22 RENTS. (*See also* 333.5.)
.23 TAXES. (*See also* 336.2.)
.24 FINANCE—(*See also* 336)—
.241 Buying and Selling.
.25 BUSINESS—
.251 Bookkeeping and Accounts. (*See also* 657.)
.252 Farm Records. (*See also* 658.)
.26 TRANSPORTATION.

.3 Physics. (*See also* 530.)

.4 Chemistry. (*See also* 540.)

.5 Bacteriology. (*See also* 589.95.)

.6

.7 Entomology. (*See also* 595.7.)

.8 Other applied sciences.

.9 Experimentation—

.91 PRIVATE EXPERIMENTS.
.92 OFFICIAL EXPERIMENT STATIONS—
.921 History and Organization.
.922 Legislation.
.923 Finances.
.924
.925
.926
.927
.928 Geographical Classification.
.929

*631.1 SOILS, 631.2 FERTILIZERS, 631.3 DRAINAGE AND IRRIGATION:

.1 Soils—

(*See also* 550, Geology.)
.11 ORIGIN AND CLASSIFICATION.
.12

.13 PHYSICS—(*See also* 530 and 630.3)—
.131 Temperature.
.132 Atmosphere.
.133 Water—
.1331 *Hygroscopic.*
.1332 *Capillary.*
.1333 *Ground Water.*
.1334 *Retention.* (*See also* 631.3.)
.134 Tillage.
.135 Reclamation.
.14 CHEMISTRY—(*See also* 540 and 630.4)—
.141 Organic Constituents.
.142 Inorganic Constituents.
.143 Analysis.

.2 Fertilizers—
.21 MINERAL AMENDMENTS—
.211 Lime.
.212 Marl. (*For* Potash Marls, *see* 631.22.)
.22 POTASH FERTILIZERS—
.221 Wood Ashes.
.222 Chlorides.
.223 Sulphates.
.23 PHOSPHORIC ACID FERTILIZERS—
.231 Natural Rock.
.232 Ground Bone.
.233. Soluble or Partly Soluble.
.234 Phosphatic Slags.
.24 NITROGEN FERTILIZERS—
.241 Ammonia Salts.
.242 Nitrates.
.243 Organic Nitrogen.
.244 Fish.
.245 Blood.
.246 Tankage.
.247 Vegetable Nitrogen Fertilizer.

.25 COMPOUND FERTILIZERS.
.26 BARNYARD MANURE—
.261 Production.
.262 Preservation and Storage.
.263 Composition.
.264 Application.
.265 Valuation.
.27 VEGETABLE AMENDMENTS—
.271 Muck.
.272 Leaves.
.273 Seaweed.
.274 Green Manures.
.28 FERTILIZER EXPERIMENTATION.
.29A
B LEGISLATION.
C STATISTICS.
D INSPECTION.

.3 Drainage and Irrigation—

.31 DRAINAGE. (*For* Drainage other than Agricultural, *see* 627.5.)

.32 IRRIGATION—(*See also* 626.8. *For* Geographical classification of this subject, *see* 940 to 999, D. D. C.)—
.321. Measuring Water.
.322 Methods of Applying Water.
.323 Duty of Water.
.324
.325
.326
.327
.328
.329

***632 PLANTS, HORTICULTURE:**

.001 Bibliography. (*See also* 580.)
.002 Compends.
.003 Dictionaries, Encyclopædias.
.004 Essays, Lectures, Addresses.
.005 Periodicals.
.006 Societies.
.007 Study and Teaching.
.008 Official Publications, Reports, etc.
.0091 History.
.0092 Legislation.
.0093 Statistics.

.01 COMPOSITION AND VALUATION. (*See also* 636.031.)
.02 CULTURE—
.021 Choice and Preparation of the Soil.
.022 Seeds and Germination.
.023 Planting and Transplanting.
.024 Crossing, Budding, Grafting, Layering (technique)
.025 Cultivation.
.026 Manuring.
.027 Training and Pruning.
.028 Forcing.
.029 Protection from Wind, Frost, etc.

.03 HINDRANCES TO GROWTH—
.031 Vegetable Parasites. (*See also* 581.23.)
.032 Weeds. (*See also* 580.)
.033 Insects. (*See also* 630.7.)
.034 Birds. (*See also* 590.)
.035 Animals. (*See also* 590.)
.036 Physiological Diseases. (*See also* 581.21.)

.04 USES.
.05 BREEDING.
.06 HARVESTING, CURING, STORAGE.
.07 PACKING, SHIPPING, MARKETING.
.08 MANUFACTURED PRODUCTS.
.09 EXHIBITING, JUDGING.

***633. GRAINS, GRASSES, FIBERS, TEA, TOBACCO, ETC., AGRONOMY** (*See also* 632):

(Divide like 632 with 00 and 0 headings. Each subject included under numbers 633, 634, and 635 may further be divided by the 0 headings, as 633.105, Breeding cereal grains, or 633.18031, Vegetable parasites affecting wheat.)

.1 Cereal Grains—

.11 BARLEY.
.12 BUCKWHEAT.
.13 MAIZE.
.14 MILLET.
.15 OATS.
.16 RICE.
.17 RYE.
.18 WHEAT.
.19 OTHER.

.2 Forage Crops—

.21 GRASSES—
.211 Bluegrass.
.212 Cereal Grasses.
.213 Fescues.
.214 Orchard Grass.
.215 Redtop.
.216 Timothy.
.217
.218
.219 Other.

.22 LEGUMES—
.221 Alfalfa.
.222 Clovers.
.223 Cowpeas.
.224 Soy Beans.
.225 Vetches.
.226 Field Peas.
.227
.228
.229 Other.

.23 SAGES.
.24 SALT BUSHES.
.25
.26
.27
.28
.29 OTHER.

.3 Root Crops and Tubers—

.31 BEETS.
.32 CARROTS.
.33 MANGEL-WURZEL.
.34 PARSNIPS.
.35 POTATOES.
.36 RUTABAGAS.
.37 TURNIPS.
.38
.39 OTHER.

.4 Sugar-Yielding Plants—(*See also* 664)—

.41 BEETS.
.42 CANE.
.43 MAPLE.
.44 PALM.
.45 SORGHUM.
.46
.47
.48
.49 OTHER.

.5 Alkaloidal Plants—

.51 CINCHONA.
.52 COCOA. (*See also* 663.9.)
.53 COFFEE. (*See also* 663.9.)
.54 KOLA.
.55 POPPY.
.56 TEA.
.57 TOBACCO.
.58
.59 OTHER.

.6 Starch-Yielding Plants.
.7 Textiles—(*See also* 677)—
.71 COTTON.
.72 FLAX.
.73 HEMP.
.74 JUTE.
.75 RAMIE.
.76
.77
.78
.79 OTHER.
.8 Tannin-Yielding Plants—
.81 CANAIGRE.
.83 SUMACH.
.89 OTHER.
.9 Other.
.91 RUBBER-YIELDING PLANTS. (*See also* 678.)

***634. FRUITS, ORCHARDS, VINEYARDS, POMOLOGY; FLOWERS, FLORICULTURE; FORESTRY** (*See also* 632 and 710):

.1 Pomology—
(Divide like 632 with 00 and 0 headings.)
.11 TREE FRUITS, ORCHARD CROPS—
.111 Pomaceous Fruits—
.1111 *Apple.*
.1112 *Pear.*
.1113 *Quince.*
.1114
.1115
.1116
.1119 *Other.*
.112 Drupaceous Fruits—
.1121 *Apricot.*
.1122 *Cherry.*
.1123 *Date.*
.1124 *Nectarine.*

.1125 *Olive.*
.1126 *Peach.*
.1127 *Persimmon.*
.1128 *Plum.*
.1129 *Other.*
.113 Citrus and Other Fruits—
.1131 *Banana.*
.1132 *Citron.*
.1133 *Fig.*
.1134 *Lemon.*
.1135 *Lime.*
.1136 *Orange.*
.1137 *Pineapple.*
.1138
.1139 *Other.*
.12 SMALL FRUITS AND BERRIES—
.121 Blackberry.
.122 Cranberry.
.123 Currant.
.124 Gooseberry.
.125 Mulberry.
.126 Raspberry.
.127 Strawberry.
.128
.129 Other.
.13 GRAPES (VITICULTURE).

.14 NUTS—
.141 Chestnut.
.142 Chinquapin.
.143 Hazelnut.
.144 Hickorynut.
.145 Pecan.
.146 Walnut—
.1461 *Butternut.*
.1462 *Black Walnut.*
.1463 *Persian Walnut.*
.148
.149 Other.

.2 Floriculture—
(Divide with 00 and 0 headings.)
.21 GREENHOUSE MANAGEMENT.
.22 CONSERVATORY MANAGEMENT.
.23 HOT BEDS, COLD FRAMES.
.24 WINDOW AND BALCONY GARDENS.
.25 HOUSE PLANTS (GENERAL WORKS). (*See also* 634.2729.)
.26 OUTDOOR FLORICULTURE—(*See also* 634.27)—
.261 Bedding Out.
.27 FLOWERING PLANTS.

.28

.29 OTHER.

.9 Forestry.

***635. KITCHEN GARDEN (OLERICULTURE)** (*See also* 632):

(Divide like 632 with 00 and 0 headings.)

.1 Edible Roots—

.11 Beets.
.12 Carrots.
.13 Horseradish.
.14 Parsnips.
.15 Radish.
.16 Salsify.
.17 Sweet Potato.
.18 Turnip.
.19 Other.

.2 Edible Stems—

.21 Celery and Celeraic.
.22 Kohl-rabi.
.23 Leek and Garlic.
.24 Onion.
.25 Potato.
.26 Rhubarb.
.27
.28
.29 Other.

.3 Edible Leaves—

.31 Aromatic Herbs.
.32 Brussels Sprouts.
.33 Cabbage.
.34 Kale.
.35 Lettuce.
.36 Spinach.
.37
.38
.39 Other.

.4 Edible Flowers—

.41 Artichoke.
.42 Cauliflower.
43
44
.45
.49 Other.

.5 Edible Fruits—

.51 Cucumber.
.52 Eggplant.
.53 Muskmelon.
.54 Pepper.
.55 Pumpkin.
.56 Squash.
.57 Tomato.
.58 Watermelon.
.59 Other.

.6 Edible Seeds—

.61 Beans.
.62 Corn.
.63 Peas.
.64
.65
.69 Other.

.7 Mushrooms.

***636. DOMESTIC ANIMALS, ANIMAL HUSBANDRY:**

(*See also* 619, Veterinary medicine, and 599.7, Zoology.)

.001 Bibliography.
.002 Compends.
.003 Dictionaries, Encyclopædias.
.004 Essays, Lectures, Addresses.
.005 Periodicals.
.006 Societies.
.007 Study and Teaching.

.008 Official Publications.

.0091 History. } Arranged geographically as under
.0092 Legislation. } 900, History.
.0093 Statistics. } (*See* Dewey Classification.)

.01 PEDIGREE RECORDS, HERD, FLOCK, AND STUD BOOKS (ASSOCIATION RECORDS)—

.011 Horses, Asses, Mules.
.012 Cattle.
.013 Sheep, Goats.
.014 Swine.
.015 Poultry.
.016 Birds.
.017 Dogs.
.018 Cats.
.019 Other Animals.

.02 BREEDS.

.03 FEEDS AND FEEDING—

(*See also* 619.03, Hygiene of Feeding. For human foods, *see* 640, Domestic Science.)

.031 Composition and Valuation—

.0311 *Analyses*—

.03111 By-products.
.03112 Cereal grains.
.03113 Corn-plant and corn silage.
.03114 Feeding stuffs—miscellaneous.
.03115 Forage plants and hay.
.03116 Legumes.
.03117 Mosses.
.03118 Nutritive groups.
.03119 Patent feeds.

.0312 *Analyses Continued*—

.03121 Roots and tubers.
.03122 Skim milk.
.03123 Soiling crops.
.03124 Silage.
.03125 .

.03126
.03127
.03128
.03129
.0313
.0314
.0315 *Compiled Analyses.*
.0316 *Composition and Use.*
.0317
.0318
.0319 *Valuation.*
.032 Nutritive Values—
.0321 *Actual Digestibility.*
H Horses.
R Ruminants.
C Cattle.
Sh Sheep.
Sw Swine.
P Poultry.
.03211 By-products. (*See* .0311 for further headings.)
(Sub-divide this and following with letters, like 636.0321, if necessary, *e. g.*, 636.03211c. Digestibility of by-products by cattle.)
.0322 *Actual Digestibility,* continued.
.0323 *Artificial Digestibility.*
.0324 *Calculated Digestibility.*
.0325 *Compiled Digestibility.*
.0326 *Fuel Value.*
.0327 *Feeding Value.*
.0328
.0329
.033 Feeding Standards.
.034 Rations—Compilation, etc.
.035 Methods and Practice.
.036 Nutrition in Domestic Animals. (*See also* 591.13 and 619.02.)
.037

.038

.039

.04 CARE AND HOUSING. (*See also* 619.03, Hygiene.)

.05 BREEDING—(*See also* 575, Evolution; 591.56, Physiological Zoology; 591.3, Embryology)—

.051 Pure Breeding.

.052 Grading.

.053 Mixed Breeding.

.054 Cross Breeding.

.055 Hybridizing.

.056

.057 Selection.

.058 Methods and Technique.

.059

.06 COST, YIELD, PROFIT.

.07 MARKET CLASSES, MARKETING.

.08 PRODUCTS—(*See also* 664.9)—

.081 Meat.

.082 Fibres.

.083 Milk and its Products. (*See* Dairying.)

.084 Leather and Pelts.

.085 Fats and Oils.

.086 Stock Foods.

.087 Fertilizers. (*See also* 631.245.)

.088

.089

.09 EXHIBITING, FITTING, AND JUDGING.

.1 H, Horses; A, Asses; M, Mules—

(*See also* 798, Horsemanship and Racing.)

.11H

.12H BREEDS—(*See also* 636.02)—

.121H Pony Breeds—

.1211H *Shetland.*

.1212H *Welsh.*

.1213H

.1214H

.1215H

.1216H

.1217H

.1218H

.1219H *Other.*

.122H Saddle Breeds—

.1221H *Arabian.*

.1222H

.1223H

.1224H *Kentucky Saddle Horse.*

.1225H

.1226H

.1227H

.1228H *Thoroughbred.*

.1229H *Other.*

.123H Light Harness Breeds—

.1231H *American Trotter.*

.1232H

.1233H

.1234H

.1235H *Orloff Trotter.*

.1236H

.1237H

.1238H

.1239H *Other.*

.124H Coach Breeds—

.1241H

.1242H *Cleveland Bay (Yorkshire).*

.1243H *French Coach.*

.1244H *German Coach.*

.1245H *Hackney.*

.1246H *Hanoverian.*

.1247H *Oldenburg.*

.1248H *Trakenof.*

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.1252H *Clydesdale.*

.1253H *English Shire.*

.1254H *Percheron and French Draft (Norman).*

.1255H

.1256H

.1257H

.1258H *Suffolk Punch.*

.1259H *Other.*

13H FEEDS AND FEEDING—(*See also* 636.03)—

.131H Stallions.

.132H Brood Mares and Fillies.

.133H Colts.

.134H Work Horses.

.135H Fattening Horses for Market.

.136H

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.139H

.14H CARE AND HOUSING. (*See also* 636.04 and 682.1.)

.15H BREEDING. (*See also* 636.05.)

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.19H EXHIBITING, FITTING, JUDGING, TRAINING, AND EDUCATION. (*See also* 636.09.)

.1A Asses. (Divide as above, so far as necessary.)
.1M Mules. (Divide as above, so far as necessary.)
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      .2212 *Galloway.*
      .2213 *Hereford.*
      .2214 *Polled Hereford.*
      .2215 *Shorthorn.*
      .2216 *Sussex.*
      .2217 *West Highland.*
      .2218
      .2219 *Other.*
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      .2222 *Ayrshire.*
      .2223 *Channel Island Breeds—*
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        G Guernsey.
        J Jersey.
      .2224 *Dutch Belted.*
      .2225 *French Canadian.*
      .2226 *Holstein.*

.2227 *Kerry.*
.2228
.2229 *Other.*
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.2231 *Brown Swiss.*
.2232 *Devon.*
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.2234 *Polled Durham.*
.2235 *Red Poll.*
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.2239 *Other.*
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.27 MARKETING, MARKET CLASSES. (*See also* 636.07.)
.28 PRODUCTS—(*See also* 636.08. *For* Milk, *see* 637.1)—
.281 Meat Products. (*See also* 664.9.)
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.284 Leather and Pelts.
.285 Tallow, etc.
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.3S Sheep (G, Goats)—

.31S FARM RECORDS.

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.321S Fine Wool Breeds—

.3211S *American Merino and Wrinkly Breeds.*
.3212S *Delaine Merino and Delaine Breeds.*
.3213S *American and Delaine Merinos. Type A.*
.3214S *American and Delaine Merinos. Type B.*
.3215S *American and Delaine Merinos. Type C.*
.3216S
.3217S *Rambouillet Merino.*
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.322S Medium Wool Breeds—

.3221S *Cheviot.*
.3222S *Dorset.*
.3223S *Hampshire Down.*
.3224S *Oxford Down.*
.3225S *Shropshire.*
.3226S *Southdown.*
.3227S *Suffolk Down.*
.3228S *Tunis.*
.3229S *Other.*

.323S Coarse Wool Breeds—

.3231S *Black-Face Highland.*
.3232S *Cotswold.*
.3233S *Leicester.*
.3234S *Lincoln.*
.3235S *Persian Fat-Rump.*

.3236s *Persian Fat-Tail.*
.3237s *Romney Marsh.*
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.334s Lambs—Fattening.
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.337s
.338s
.339s
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.37s MARKETING, MARKET CLASSES. (*See also* 636.07.)
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.33G FEEDS AND FEEDING. (*See also* 636.03.)
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  .383G Milk. (*See* Dairying.)
  .384G Goatskin and Pelts. (*See also* 675.)
  .385G Tallow, etc.
  .386G
  .387G
  .388G
  .389G
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.5213F Java.

.5214F Dominique.

.522F *Asiatic Class—*

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.5222F Cochin.

.5223F Langshan.

.523F *Mediterranean Class—*

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.5241F Polish.

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.5251F Hamburg.

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THE UNIVERSITY OF WYOMING

AGRICULTURAL COLLEGE DEPARTMENT

SEVENTEENTH ANNUAL REPORT

. . . OF THE . . .

U. S. Agricultural Experiment Station

. . . OF . . .

WYOMING

1906-1907

LARAMIE, WYOMING,
U. S. A.

WYOMING
Agricultural Experiment Station

UNIVERSITY OF WYOMING.

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B. C. Buffum, M. S.*........Director, Agriculturist and Horticulturist
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R. E. Hyslop, M. S.*........................Assistant Agronomist
F. E. Hepner, B. S........................Research Chemist
M. J. Hamilton........................Clerk and Stenographer

*Resigned June 1, 1907.

Letter of Transmittal.

U. S. AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF WYOMING.

To His Excellency, Bryant B. Brooks, Governor of Wyoming.

SIR:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating Agricultural Experiment Stations, and the act of Congress approved March 16, 1906, known as the Adams Act, I have the honor herewith to submit the Seventeenth Annual Report of the U. S. Agricultural Experiment Station of Wyoming, for the fiscal year ending June 30, 1907.

B. C. Buffum
Director.

UNIVERSITY OF WYOMING, June 30, 1907.

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Report of the Station Staff.

Report of the Director.

The present report marks the close of seventeen years of investigational work by the Wyoming Experiment Station. In the sixteen reports preceding the present one will be found general statements which give the history of the research work in Wyoming, and also a statement of the origin and purpose of the Experiment Station, and a general account of the provisions of the Hatch Act, which has been the organic law under which the Experiment Station is operated. In the last annual report we made some statements of the work provided for under the Adams bill, which was approved March 16, 1906. That report gives an outline of the work adopted under the provisions of the Adams Act. It takes some time for our people to come to a full understanding of the general acts of the Government which support research work in the several states, and to become interested in that work and make it of value to themselves. Agriculture was very new in Wyoming in 1890, when experimental work was first begun, and on January 10, 1891, the Legislature authorized the University of Wyoming to receive appropriations provided by Congress through the Hatch Act, for the establishment of an Experiment Station. Briefly, the purpose of an Experiment Station is research in agriculture, and provision is made for the publication of such bulletins and reports as will enable the people of the several states to put into practical use the results of this research. There are now Experiment Stations in all of the states and territories, and the work of each Station is primarily for the benefit of the people in its own state. The moneys appropriated for the work are taken from the funds of the general treasury of the United States, and are not directly supported by taxation in the several states. The work is so highly

appreciated, however, in most of the states, that the Legislatures have appropriated funds to supplement the Government moneys carrying out the work of the Station. This money being appropriated for research cannot be used in any sense for purposes of instruction, and while there has sprung up in the several states much educational work in which the Experiment Station is of great value, through supplying data of results and illustrative material, the funds for such instructional work must arise from some other source.

A brief history of the research work undertaken by the Wyoming Station may be of general interest. At the time the Experiment Station was first organized the Board of Trustees of the University desired to apply these funds so they would be of as great use as possible to widely separated sections of the State. To that end they established, in addition to the main Station connected with the Agricultural College of the University at Laramie, five sub-stations. These sub-stations consisted of farms ranging in size from forty acres to one hundred and twenty acres, located at Wheatland, Laramie County; at Sundance, Crook County; at Sheridan, Sheridan County; at Saratoga, Carbon County, and at Lander, Fremont County. At that time there was practically nothing known of the agricultural possibilities in the different parts of the State, and these Experiment Stations did pioneer work as demonstration farms, proving the class and character of agriculture which would be successful in the regions they represented. In these early days there was little technical work undertaken, though some of the comparative experiments carried out in a like manner at the different Stations threw considerable light on comparative effects of altitude, soils, climate, and the resultant crop. The appropriations of funds from the Hatch Act to the different sub-stations, scattered the work of the Station to a considerable extent, and the Agricultural Department in charge of the appropriation made by Congress notified our state authorities that this scat-

tering of the funds was not in line with the purposes of the Hatch Act, and that it would be necessary to abandon the making of appropriations from the Hatch Act fund to the sub-stations. This necessitated the entire abandonment of sub-station work, as in Wyoming there was no state or other fund which could be used for their support. The sub-stations, therefore, were disposed of, with the exception of the one at Lander, which we have been able to continue through leasing to private parties, and some experimental work has been continued there with orchard and small fruits. This work has been supported by state appropriations for the last two years, and the last Legislature appropriated $2,000 for the two years ending in 1909. The Experiment Station at Laramie has received and used all funds provided by the Hatch Act, amounting to $15,000 per year, since 1895. The Station does not consist, as many suppose, merely of an agricultural farm, and a live stock department connected therewith, but is made up of the several departments which are organized for the conducting of scientific research. The work which is being done covers a field broad enough to discover the underlying principles of our agriculture. At the close of the present year we have published, in addition to the seventeen annual reports, seventy-four station bulletins, giving the results of the scientific research in the several departments which compose the Experiment Station staff. Perhaps the most distinguishing feature of the Wyoming Station work has resulted from the location of this Station at an altitude of over 7,000 feet above the sea. Because of this high altitude the work has differed from that of all other Experiment Stations, and the results of this work have been of wider interest, because they were obtained under unusual conditions. In agricultural cropping alone some discoveries have been made which were new to science. In some of the more technical work, such as that with soils and alkalies, the effect of alkalies on seed germination and plant growth, the absorption of

water containing alkali salts by seeds, new discoveries have been made, and all of this work has a more or less direct application to the agriculture of the State. In the pioneer work of the Station, much has been done which was not true research. I refer to such work as that which is now classed under the term of survey work. Some of the bulletins of our Station which have been of the most interest to our own people are those upon, "The Flora of the State," "The Trees of Wyoming," and "The Birds of Wyoming," and while this work has been truly scientific, it has not been true experimental research, and under the rulings of the Department the station funds should be confined to experimental investigations.

During the past five years the Station has taken up investigations with live stock. This is eminently fitting in Wyoming, where the live stock interests are paramount, and the plans adopted during the last year greatly increase the investigations relating to the stock industry. For sixteen years the Station carried on its research work with no increase of funds, and it has always been more or less difficult to confine the expenditures to the exact interpretation of the Hatch Act. There have been no wide digressions, however, and on account of the pioneer conditions and the peculiar conditions of our Station some latitude has probably been allowed by the Office of Experiment Stations. Much new encouragement has been received during the past year from the passage of the Adams Act, and from the more favorable attitude toward our agricultural investigations by the State Legislature and the people of the State in general. So far is this true that funds made available from various sources have more than doubled the moneys coming to the Experiment Station within the year. There was obtained from the Adams fund just at the close of the last fiscal year $5,000, and during the present fiscal year $7,000 have been obtained. Through a co-operation with the United States Department of Agriculture in sheep breeding

work, the State has received the equivalent of about $5,000 additional, and the last Legislature, in addition to presenting to the University, for Experiment Station purposes, the old abandoned penitentiary buildings and land, made an appropriation of $5,000 for the purpose of repairing these buildings and putting them in better condition for Station work. The live stock work also has enabled the Station to obtain a considerable fund from sales of fat stock and breeding animals. During the present fiscal year the sales fund has amounted to a total of $4,951.41. Through the action of our Executive Committee, in accordance with the laws and regulations governing Station funds, the money obtained from these sales is re-appropriated for the use of the Station. This has enabled us to purchase feed for the fattening of lambs, and other stock, and to complete the first installation of the wool scouring plant for the beginning of new investigations relating to the wool industry.

Present Organization of the Station.—The Experiment Station is administered by the Board of Trustees of the University of Wyoming. All matters which require action in the interim of the semi-annual meetings of the board are in charge of the Agricultural Executive Committee, consisting of three resident members of the board. The Executive Committee makes appointments to fill vacancies, audits the bills of the Station, adopts plans of work, approves manuscripts for publication, and authorizes their printing, and passes upon readjustment of appropriations, or re-appropriates the sales fund. The President of the University is President of the Agricultural College, and as such is chairman of the Experiment Station Council. The Station Council is made up of the members of the Experiment Station staff, with the President of the University as chairman, and Secretary of the Board of Trustees as Secretary of the Council. Since 1902, the Director has been the executive head of the Experiment Station, and the staff includes the heads of the different scientific depart-

ments, Chemistry, Botany, Agriculture, and Physics, with the assistants and associates who are doing research work. The Station Council meets from time to time at the call of the Director, to pass upon plans of work in the several departments, to adopt materials for the Station bulletins and reports which they recommend to the Executive Committee for publication. Under a more recent rule of the Station Council, the writer of a bulletin may select two other members of the Station staff to aid him in reading proof of any publication for which he is responsible.

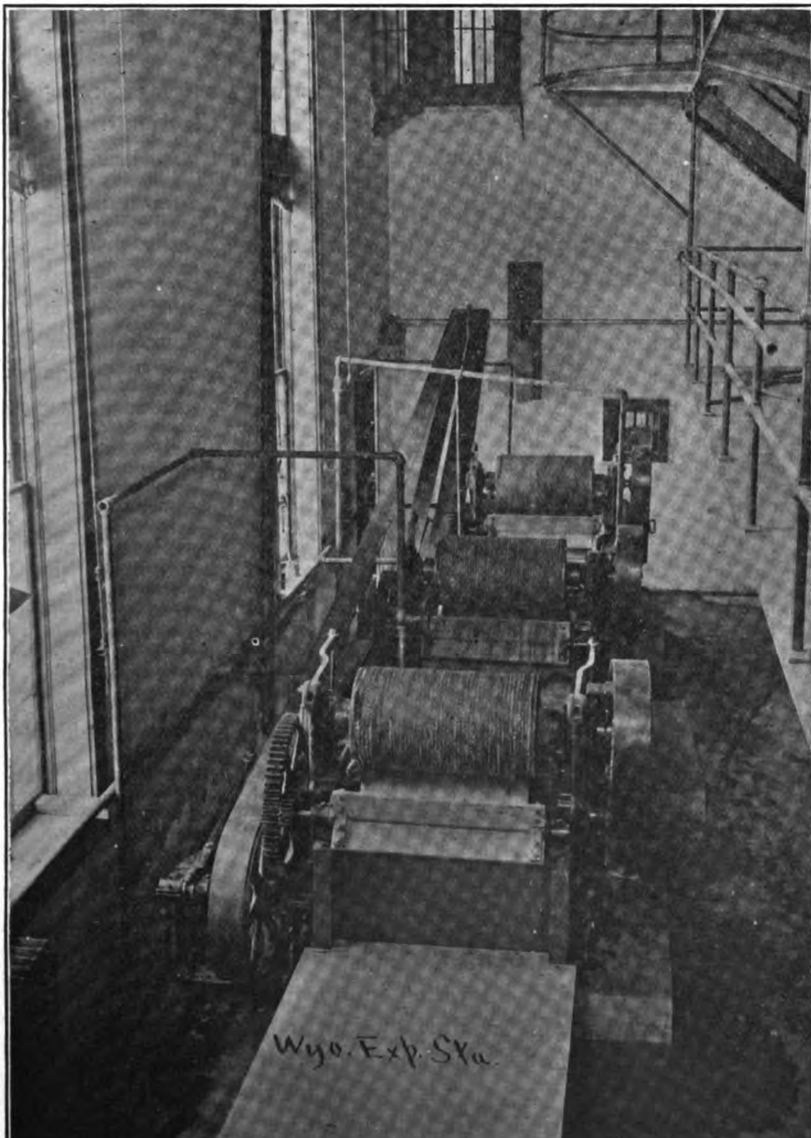
Changes in the Experiment Station Staff.—Mr. Herbert T. Nowell has remained with the Station during the year as Research Irrigation Engineer and as aid to the Professor of Agriculture in the dry farm investigations, under the Adams fund. He has regularly made trips each week to the Cheyenne dry farm, during the cropping season, to collect soil samples, the moisture content of which are determined in the Chemical Department. At the beginning of the past fiscal year, Mr. R. E. Hyslop, M. S., was appointed assistant in Agronomy, and has had more or less direct charge of the agronomy work at the Station farm, keeping the notes and records for the year. On June 1, 1907, Mr. Hyslop resigned. Mr. G. E. Morton, M. L., B. S., resigned as Associate Professor of Animal Husbandry, on June 1, and his place was not filled during the fiscal year covered by this report. Mr. B. C. Buffum, M. S., resigned as Director of the Experiment Station and Professor of Agriculture and Horticulture, on June 1 of the present year, and his successor was not chosen by the annual board meeting. Mr. Frank Smith, B. S., was made scientific aid in the Agricultural Department, and has taken care of the greenhouse laboratory and experimental work carried on there during the year, has taken the meteorological observations, making monthly report to the Section Director of the Weather Bureau. Mr. Smith's report as Meteorologist, giving a summary of observations for the year, is published herewith.

At the beginning of the present fiscal year Miss L. Case resigned as stenographer, and on December 1 Mr. M. J. Hamilton was appointed clerk and stenographer of the Station.

Investigations Under the Adams Fund.—Early in the year a letter was received from the Office of Experiment Stations approving the expenditures made from the first appropriation of the Adams Act, and a little later a congratulatory letter was sent to the Director complimenting the Station on successfully expending this money for the State in accordance with the provisions of the act. During the present year there has been $7,000 to expend under the provisions of the Adams Act, and it has been necessary to confine these expenditures strictly to technical investigations in the following three lines of work: First, sheep and wool investigations; second, technical studies of soil moisture and the use of moisture by plants; third, botanical investigations. Estimates were made of the probable expenses of starting these lines of work, and more than was anticipated was spent in establishing the sheep and wool investigations, and moisture studies, and less in carrying out the botanical investigations. We have found the installation of the wool scouring plant more expensive than our first estimates. Six hundred dollars was set aside for the purchase of the scouring machinery. We found that the smallest bowls made, and for our experimental work we only required a small capacity, was a machine manufactured by the James Hunter Machine Company of North Adams, Mass. Through a special concession to our Experiment Station we obtained a two-bowled machine and a rinsing bowl, for $600 at the factory. This was only a small part of the ultimate expense, for the cost of freight, hauling, installation in the old penitentiary building, the purchase of power, pulleys, and belting, and water and steam piping and tanks, made the total amount expended on this part of the Station apparatus over $3,000. Fortunately we were able to use more money than had at first been thought possible on account of the sales

of the sheep and other live stock which had been fattened for market. It must be said that the wool scouring work has only been fairly begun. The first series of shrinkages determined show a variation in shrinkage of Wyoming wools of from 55 per cent to more than 78 per cent. This indicates the great practical value which should come to our sheepmen from the Station carrying out such wool studies. The whole plan for sheep and wool investigations is one which involves a wide range of study in a field which has not been entered by other Station workers. It is known in a practical way that profound changes are produced in wool by climate, feed, soils, alkali salts, the breeding of sheep and crossing one breed upon another. All these changes and what may be expected by the sheepman from his method of managing his flocks are almost entirely unknown. In order to make our studies as complete as possible, the Station secured samples of nearly all of the breeds of sheep recognized as of importance, and reference is here made to the report of the Animal Husbandman, which outlines what was done in securing sheep for the breeding and crossing experiments. The Government co-operative sheep breeding experiments also fit nicely into plans for these wool investigations, as they will enable the wool expert to make studies of the effect of the different conditions on the character and value of our wools.

The dry farm, or more properly, moisture investigations of the year have been carried out along two different lines. Through the season the Irrigation Engineer has visited the Cheyenne demonstration farm at least once each week, in order to secure soil samples to show how different methods of soil culture, and the growth of different crops on these different fields influence the moisture. Reference is here made to Mr. Nowell's preliminary report giving the results of the first season's work at Cheyenne. An investigation which was carried along at the same time by myself, as Professor of Agriculture, was outlined to throw more light on the use of



WOOL SCOURING PLANT (3-BOWL MACHINE) IN OLD PENITENTIARY BUILDING.

moisture by plants, and its evaporation from soil surfaces. This experiment is only just being completed, and an account will be found in the report of the Agriculturist. I would refer the reader to the report of the Botanist as an indication of the line of work which he is conducting under this fund.

In reply to a recent letter from the Office of Experiment Stations making inquiry as to whether our Station would wish to change or modify the lines of investigation, I replied that, in my opinion, all of the increase for next year will be needed for the development of the plans of work already adopted for the Wyoming Station. When we made the plans covering the three lines of investigation above outlined, we had in mind their development and continuation for at least four or five years. Arrangements have been made to put an expert in charge of the wool investigations, and to that end, John A. Hill, a student in the long course in Agriculture at the University, was prepared a year ahead to take up this kind of work. He spent the last half of his senior year in wool studies at the Philadelphia Textile School, at the same time so finishing his work that he could graduate with his class. Mr. Hill is a man of mature years and large ability, and there can be no doubt of his carrying out the wool investigations next year with much credit to himself and to the institution. A sheep herdsman has been employed who gives all of his time to the care of the different breeds of sheep now owned by the Experiment Station, as stated under the heading, Co-operation. The Government breeding sheep are being run on the range and under the personal direction of the F. S. King. Bros. Company of Laramie. These gentlemen have for many years been interested in the improvement of their range sheep through the introduction of the best blood possible, and the continued breeding of their flocks for a definite purpose. They own their range, which lies within a few miles of the Experiment Station, having it divided into ideal summer and winter ranges, and they are able to give a service

to the Station which it would be impossible to obtain from anyone located at a distance.

Co-operation.—The Experiment Station entered into several lines of co-operation during the last fiscal year. These co-operative investigations are such as will bring advantage to the Station, and enable us to carry out more extensive and important work than could be accomplished by the Station alone. They may be outlined as follows:

Co-operative Sheep Breeding.—Previous to the present year there had been some attempt to induce the Bureau of Animal Industry of the United States Department to aid us in some of our stock breeding experiments. Because of the important results which had been obtained by the King Bros. in their own sheep breeding work, and also because of the fact that Wyoming is one of the first wool producing states in the Union, and our conditions are particularly favorable for the production of superior wool and mutton, the Department finally consented to enter into co-operation with our Station and supply the necessary funds to obtain foundation breeding flocks of ewes. In September articles of agreement between the Station and the Bureau of Animal Industry were entered into, whereby that bureau through its Animal Husbandry Department agreed to expend the sum of approximately $5,000 for this work in Wyoming. The report of the Animal Husbandman shows what was done in obtaining this basic herd from the flocks owned by the best sheep breeders of the western states. The experiment is now well under way, and if carefully followed out, keeping technical notes of every influencing factor, it must result in great good, not only to the sheepmen of our own State, but to the entire sheep industry of the West. The Station has made arrangements with the King Bros. of Laramie to run these sheep through the year on the open range, where they will be treated the same as ordinary range sheep. Because of not having time to secure proper sires of our own, arrangements were made to use the prize

winning bucks belonging to King Bros. for the first year's breeding. The cost of running these sheep on the range, outside of extra help at lambing, and breeding and shearing time, in order to obtain the scientific notes, is 20 cents per head per month.

Co-operation in Breeding Polled Herefords.—During the year a co-operative agreement has been entered into between the Station and J. M. Carey & Bro., whereby the Station has furnished to the Carey Company, under direct charge of Mr. Robert Carey, the Polled Hereford bull Mutation 2d, which was purchased from Warren Gammon of Des Moines, Iowa. The main part of the agreement between Mr. Carey and the Station is, that the Experiment Station is to receive one-fourth of the calves sired by said bull, Mr. Carey agreeing to breed him to from 40 to 60 of his best registered Hereford cows. This agreement is to cover a period of two years, after which time the bull is again to become the property of the Experiment Station. This co-operation will be mutually advantageous to both parties. It enables Mr. Carey to get into his herd of Herefords the very best Double Standard Polled Hereford blood which can be obtained. It gives the Experiment Station opportunity to become equipped with some good Polled Hereford cattle. Heretofore, on account of lack of funds, it has been impossible for our Station either to purchase cattle for its experimental work or to properly fit up our fields and buildings for the care of such stock. The farm has been better equipped for this work, and by the time the young stock is obtained through this co-operation, the Station farm can be put in good condition to receive them.

Barley Co-operation.—Last season through the agreement between the Cereal Division of the United States Department of Agriculture and the Station, we obtained over 330 varieties of barleys for planting at Laramie. The report of these barleys will be found in connection with the report of the Agronomist for the year. The present season our barley investigations are

carried out in co-operation with the Bureau of Plant Industry, and some new barleys have been obtained and planted on the Station farm. In addition to this, the most promising sorts of last year's trials have been planted in larger plats to increase the seed and give barley for experimental study. We believe that barley is destined to be one of the most important Wyoming crops, especially at our high altitudes. Feeding barleys are of vast importance to the State, because of their being approximately equivalent to corn for fattening purposes, and because we cannot produce corn under our conditions of short seasons and cold nights. It is believed also that our brewing barleys have superior qualities, and Southern Wyoming at least should become a large producer of export barley. Our experiments, therefore, with these grains should be of much interest and value.

Dry Farm Co-operation.—Instead of making an attempt to establish a farm with soil culture plats and crops, the Station entered into co-operation with the people of Cheyenne and the Office of Irrigation Investigations, beginning field studies of soil moisture at Cheyenne and at Newcastle. Our Station appropriated $500 toward the establishment of a demonstration farm at Newcastle, in Weston County, where the United States Office of Irrigation and Drainage Investigations is to make tests of supplementary irrigation, and the dry farm and moisture studies are to be looked after by our Station. The first year's work at Cheyenne in these moisture studies has given results of more than usual interest. They indicate that it will be some years before the underlying principles of soil moisture and its conservation, and the use of moisture by dry farmed crops, will be fully understood. Anyone interested in this subject is refered to the preliminary report of the Irrigation Engineer, contained in these pages.

Co-operation With the Bureau of Plant Industry.—This co-operation consists of tests being made at Laramie of all the varieties of field pease which can be obtained from different

parts of the world. Four years ago our Experiment Station began investigations with Canadian field pease as a fattening ration for lambs, allowing the sheep to harvest the pease in the field. Last year we made some comparative tests with different varieties of pease, and the experiments, so far as carried out, are so promising of results of great value to our high altitude farmers and stockmen that we were glad to avail ourselves of the opportunity to try all of the kinds of pease obtainable. Another co-operation with the United States Department is in making some breeding trials of all of the strains of alfalfa obtainable, seed of which has been furnished us by the Division of Agrostology. Both the work with pease and that with alfalfa will be jointly carried on by the Station at Laramie, and on the breeding farms of the Wyoming Plant and Seed Breeding Company, at Worland, Big Horn County.

Legislation of Interest to the Station.—The Fifteenth General Assembly of the State of Wyoming, which met in January, 1907, passed acts which were of vital importance to the Experiment Station. They donated to the University of Wyoming, for the use of the Wyoming Experiment Station and Agricultural College, the old penitentiary farm, which had been abandoned by the State. This property consists of 320 acres of land joining the town of Laramie on the west, reference to which has been made in the Fifteenth Annual Report. In addition to the land there are a number of buildings which are of considerable importance. The main building consists of the central portion, which contained the administration offices of the old federal prison established in Wyoming in territorial days, and on each side are wings containing brick and steel cells. The building is a substantial structure and by remodeling and taking out the cells, it can be converted into important Station laboratories, stock judging pavilions, and other uses. There is a good grout house on the property, which has been used as the home of the Animal Husbandman. In addition to the donation of property, the Legislature appropriated the sum

of $5,000 to be used in repairing the buildings and putting the farm in condition for the live stock work of the Station. This is the most important recognition of the Experiment Station and its work which has come from our State Legislature. The place is being changed into a stock farm, and to that end the pastures are being fenced with woven wire, and considerable improvement has been made by the building of sheep feeding pens and supplying each with water from the city water system. A large part of the land in this farm has become unusable through the accumulation of seepage water, from the Pioneer Canal and adjoining lands above, and evaporation having caused the top soil to become alkalized. It is believed that a comparatively small expenditure will reclaim much of this land by the establishing of an open drain, or a simple system of blind drains.

THE OLD PETITENTIARY BUILDINGS, NOW THE EXPERIMENT STATION STOCK FARM.

The Legislature also re-enacted the clause in the general appropriation bill providing $2,000 for Farmers' Institutes, and passed a general act authorizing County Commissioners to aid local organizations for the purpose of helping the institute movement in connection with the work of the University. The Legislature re-enacted, also, the clause providing $2,000 to continue the horticultural experiments at Lander, and the Gov-

ernor reappointed the same members of the Horticultural Commission as heretofore.

Publications.—The publications of the year are as follows:

The Sixteenth Annual Report of the Director.—This contains 62 pages in the body of the report and an appendix of 96 pages. It is made up of the several reports of the members of the Station staff, the financial statements of the Treasurer, and a meteorological summary for the sidereal year ending December 31, 1906. The reports of the several workers of the Station staff contain technical statements and condensed tables, giving results of the investigations carried out in each department. This report is made by the Director to the Governor in accordance with law. The appendix contains a general classification of agricultural literature, which was prepared by Mr. G. E. Morton for the previous annual report, but on account of changes found necessary it was held for one year.

Bulletin No. 71, January, 1907, "Some Potato Diseases, Their Cause and Control," by the Botanist. This is a 40-page bulletin covering in a general way the potato diseases of the West, as determined at this and other Experiment Stations. It contains information about the prevalance of potato diseases in Wyoming during the past season, and gives instructions for spraying with formula for making solutions and directions for treatment of seed.

Bulletin No. 72, February, 1907, "Duty of Water on Field Pease in 1906," by the Irrigation Engineer. This is a 16-page bulletin, with three pages of half-tone cuts and one graphic chart. It shows the influence on yield of forage and of pease, of different amounts of water used in irrigation, and contains data of much value to the irrigation farmer at high altitudes who is producing this crop.

Bulletin No. 73, April, 1907. "Ration Experiments with Lambs, 1905-06," by the Animal Husbandman. This is an 18-page bulletin, giving the results of feeding trials of last year

with different lots of lambs. It contains six pages of cuts and a series of tables to throw light on the text.

Bulletin No. 74, May, 1907, "Ration Experiments with Swine," by the Animal Husbandman. This is an 18-page bulletin, illustrated with three half-tone cuts, and containing an appendix giving the tables of data upon which the results of our swine feeding have been worked out.

Index Bulletin D, June, 1907, "Indexing Bulletins 54 to 74," by the Secretary. This bulletin is in preparation and will bring the indexing of the Station publications down to the end of the present fiscal year.

The Ranchman's Reminder.—While not a Station publication and not paid for out of Station funds, THE RANCHMAN'S REMINDER has been of considerable value to the Station, and many of its articles report the results of Experiment Station investigations. With the June number, 1907, it has finished three and one-half years. An index was prepared and published covering the first three volumes, which closes with December, 1906. THE REMINDER is a small monthly agricultural paper, usually occupying only 12 pages. It is published as a magazine of the Agricultural College and contains no advertising other than that of the institution.

Farmers' Institutes.—Eleven institutes were held, composing 35 sessions, and having an attendance of 1,292 people. There were employed at some of these meetings six different men to deliver lectures on special subjects. These included two farmers from outside of the State, one dry farm expert in the State, the State Food Commissioner, and two Professors of Veterinary Science, from the Colorado Agricultural College. The State Legislature re-enacted the clause in the general appropriation bill, giving $2,000 for the ensuing two years for Farmers' Institute work, being placed under the charge of the Board of Trustees of the University and administered through the Agricultural Department. In addition, the Legislature passed a general Farmers' Institute bill, providing that the

Commissioners of each county could appropriate from the county funds $100 to be used in advertising and helping with Farmers' Institutes to be held by the University authorities in the several counties. This bill provides that there must be local county organizations for institute purposes. It will be noted that since the new railroad rate bill has gone into effect and passes have been generally refused, our institutes cost much more heavily than they did when transportation was available. To reach distant parts of the State it is necessary to pass through adjoining states, so passes within the State are of little aid.

We have added during the year to our institute equipment a reflectoscope outfit for illustrating agronomy and other lectures.

The showing we can make is small, but the work is well begun and, considering the fact that there is only one person to each square mile in the State, our distances and lack of railroad facilities, and the small appropriation for the work, we think the showing is a fairly good one.

FARMERS' INSTITUTES, 1906-07.

Date	Place	Number of meetings	Total attendance	Lecturers	Cost
1906					
Sept. 14	Afton	. .	. .	G. E. Morton	$ 43.40
" 17	Newcastle	. .	. .	Morton, Buffum	36.05
Dec. 20-21	Cowley	2	54	Buffum, Quaintance	
" 21-22	Basin	3	107	Buffum, Wherren, Quaintance, Nowell	
" 22-24	Worland	3	141	Buffum, Wherren, Quaintance, Nowell	217.30
" 26	Sheridan	3	139	Buffum, Wherren, Quaintance, Nowell	
" 28	Newcastle	2	81	Buffum, Dr. Cooke, Quaintance	
" 29	Pine Grove	2	42	Buffum, Dr. Cooke, Quaintance	
1907					
Jan. 8 to 12	Laramie	10	252	Buffum, Nowell, Knight, Burke, Cooke, Tisdel, Hyslop, Morton, Glover, Newsom, Quaintance	69.35
Feb. 1-2	Wheatland	6	237	Buffum, Cooke, Morton, Hyslop, Quaintance	78.95
" 27	Buffalo	4	239	Buffum, Morton, Bliss, Quaintance	250.50
20 days		35	1292	13	
Dec. 20, '06	One Reflectoscope and freight				252.56
					$948.11

Financial Statement of the Treasurer.

UNIVERSITY OF WYOMING.

AGRICULTURAL EXPERIMENT STATION

IN ACCOUNT WITH

THE UNITED STATES APPROPRIATION, 1906-1907.

DR.

To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ending June 30, 1907, as per Acts of Congress approved March 2, 1887, and March 16, 1906—

Hatch Fund	$15.000.00
Adams Fund	7,000.00

CR.

	Hatch	Adams	
By Salaries	$ 7,439.72	$2,398.00	
Labor	1,708.00	1.007.97	
Publications	904.93	....	
Postage and stationery	267.80	....	
Freight and express	223.35	386.92	
Heat, light, water, power	500.00	10.79	
Chemical supplies	119.77	389.38	
Seeds, plants, and sundry supplies	458.14	49.35	
Feeding stuffs	1,547.13	....	
Library	30.00	....	
Tools, implements, and machinery	390.49	1,688.16	
Furniture and fixtures	30.00	....	
Scientific apparatus	36.70	117.88	
Live stock	422.22	....	
Traveling expenses	261.50	596.70	
Contingent expenses	41.25	4.85	
Building and land	618.98	350.00	
Totals	$15,000.00	$7,000.00	$22,000.00

We, the undersigned, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Experiment Station for the fiscal year ending

June 30, 1907; that we have found the same well kept and classified as above; and that the receipts for the year from the Treasurer of the United States are shown to have been $22,000.00 and the corresponding disbursements $22,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887, and the Act of Congress approved March 16, 1906.

[Signed] OTTO GRAMM,
H. L. STEVENS,
A. C. JONES.

Attest:
GRACE RAYMOND HEBARD,
[SEAL] Custodian of Seal.

SUPPLEMENTARY STATEMENT.

DR.	*Farm Products*	*Total*
To receipts from other sources than the United States for the year ending June 30, 1907	$4,951.41	$4,951.41
CR.		
By Salaries	450.00	
Labor	664.61	
Postage and stationery	150.40	
Heat, light, water, and power	232.64	
Feeding stuffs	1,301.37	
Scientific apparatus	86.85	
Traveling expenses	331.55	
Contingent expenses	500.00	
Buildings and land	62.75	
Balance	1,171.24	$4,951.41

Report of the Agriculturist and Horticulturist.

B. C. BUFFUM.

On account of executive work taking up considerable time, and having some teaching to do in the Agricultural College, not so much experimentation has been possible as could be desired. The Professor of Agriculture has had assistants during the year more especially in the teaching work, though the new Agronomist kept the notes on the Experiment Station farm, and the Irrigation Engineer ably assisted in much of the farm work and investigations. We have actively engaged in some co-operation as indicated by the report of the Director, and some technical investigations have been conducted through the year. A part of the Agriculturist's salary has been paid from the Adams fund because this Department has charge of the dry farm investigations as planned. On this account I have actively looked after some moisture work and carried out an investigation with the assistance rendered me by Mr. Hill, one of our senior students, and Mr. Smith, scientific aid in this Department. The report of the moisture work carried out in the greenhouse laboratory is made as a part of this report. There have been some experiments under way for several years at our Experiment Station farm which have required some personal attention. A special study of oats and of barley have resulted in much accumulated data, and it is regretted that lack of time has prevented making a full report of these results at this time. So far as we have been able to get the work in shape for publication, it is here reported.

FENCE POST EXPERIMENT.

The writer was the first man employed by the Board of Trustees to begin the experimental investigations at the Uni-

versity of Wyoming under the provisions of the Hatch Act. I arrived on the 15th of March, 1891, and from that date until along in April of that year gave my attention to the organization of the Station work, doing the general correspondence necessary, and those preliminary things to make a beginning. It was my privilege to select the land for the Experiment Station farm, which was donated by the Wyoming Central Land and Improvement Company. After selecting this land, I personally made the surveys, dividing the 40 acres obtained into plats of an acre each, locating the headgates and laterals, and arranging for the necessary fences. The central thought was to make everything we did experimental investigation in so far as possible. To that end, and in order to determine the life of our ordinary pitch pine fence posts obtained in this locality, an experiment was planned, the results of which would indicate whether our ranchmen could apply some cheap treatment which would be profitable. It should be remembered that this experiment was begun before much attention had been given the preservation of timber outside of some tie preserving experiments that were being conducted by the railroads. The trial was made on the north line of fence extending east and west across the Experiment farm.

Plan.—From the lot of pitch pine posts bought with which to fence the forty acres, eighty average posts were selected. I believe that these posts cost fifteen cents each delivered at the farm. These eighty posts were divided into sixteen lots of five each. They were treated and set in the ground at a uniform depth of two feet, placing them one rod apart. North of the fence and running parallel with it at a distance of four or five feet was a small lateral from the canal, used by the neighbors as an irrigation ditch. South of the line of fence twelve feet of ground was set aside for a road. This was used as an approach to the farm buildings for ten years. South of the road and at a distance of twelve or thirteen feet from the fence was another

small irrigation lateral along which willow cuttings were planted.

The posts were treated and set as follows, beginning at the northeast corner of the forty acres with the first post west of the corner post, numbering from this post toward the west. The corner post was a gate post and was not included in the experiment. The different lots were as follows:

No. 1. Five posts well coated with tar to a distance of two and one-half feet from the bottom of the post.

No. 2. Five good, clean posts, not treated, as a check.

No. 3. Five posts treated with crude oil, or petroleum, two and one-half feet of the bottom of the post.

No. 4. Five posts with a tar band one foot wide, eighteen to thirty inches from the base, to protect the wood near ground surface.

No. 5. Five posts with crude oil band one foot wide, from eighteen to thirty inches from the base.

No. 6. Five posts with crude oil covering two and one-half feet of the bottom of the post, and the oil burned off.

No. 7. Five posts with coating of tar two and one-half feet of the bottom, and the tar burned off.

No. 8. Five posts with band of crude oil one foot wide, from eighteen to thirty inches from the base, and burned off.

No. 9. Five good posts, untreated, as a check.

No. 10. Five posts with tar band one foot wide, eighteen to thirty inches from base, and burned off.

No. 11. Five posts with one foot of bottom dipped in tar.

No. 12. Five posts with one foot of bottom dipped in tar and tar burned off.

No. 13. Five of the poorer posts, containing little pitch, untreated.

No. 14. Five good, well charred posts. Two and one-half feet of the bottom of these posts was simply burned to produce a protecting char.

No. 15. Five posts with one foot of bottom dipped in crude oil.

No. 16. Five posts with one foot of bottom dipped in crude oil, and oil burned off.

There was the usual brace at the corners of the fence, and one double brace at the center post. The fence consisted of four ordinary strands of barbed wire with barbs four or five inches apart. The posts were treated and all set on April 15, 1891, and were allowed to stand without disturbing until June 27, 1907, a period of sixteen years, two months and twelve days. During that time accidents happened to only two posts. These were in lot 15. Between them the wire fence was opened near the house, and within the past year two of the posts were broken off by being struck by a wagon as it passed through the gate. One of these was in fairly good condition, being broken off by the force of the blow. The other was partly rotted off with dry rot near the surface of the ground, as indicated in the notes.

Results of the Experiments.—All the posts, with the exception of lots 15 and 16, were dug up in one day, June 27th, 1907, and careful notes taken of their condition, and photographs taken for record. The accompanying table gives in condensed form the data of the condition of each set of five posts:

FENCE POST EXPERIMENT.

No of set	TREATMENT	Number whole	Number broken	Condition at bottom, per cent	Condition at ground surface, per cent	Condition of top, per cent	NOTES
1	Coal tar 2½ ft. bottom........	4	1	100	65	85	One gone at 15 yrs.; 4 would last 20 or 25 yrs.
2	No treatment	2	3	30	12	85	Three gone at about 12 yrs.; 1 would last 17 yrs; 1. 18 yrs.
3	Crude oil 2½ ft. base...........	5	0	95	75	90	Two would last 20 yrs.; 3 perhaps 30 yrs.
4	Tar band 1 ft. wide............	3	2	75	50	95	Two good as new; 1, 20 yrs.; 2, about 12 yrs.
5	Crude oil band................	5	0	95	90	98	Four good as new; 1 good for 25 yrs.
6	Crude oil and burned..........	5	0	100	98	85	All 5 practically good as new; should last 30 yrs. or more.
7	Tar 2½ ft. and burned.........	5	0	60	50	95	One good as new; 4 would probably last 20 yrs. or more.
8	Crude oil band and burned....	2	3	60	15	90	One good for 18 yrs.; 3 have been broken 3 or 4 yrs; 1 gone this year.
9	No treatment	4	1	40	35	90	One good for 20 or 25 yrs.; 2 gone now; 1, 17 yrs.; 1 off several yrs.
10	Tar band and burned..........	3	2	5	40	85	Two good for more than 20 yrs.; 2, 14 yrs.; 1, 16 yrs.
11	Tar 12 in. base..................	5	0	75	50	95	All would probably stand to 25 yrs.
12	Tar 12 in. and burned..........	4	1	50	40	80	Two would last 20 yrs.; 2, 18 yrs.; 1 broken a yr. or more.
13	No treatment	2	3	60	7	80	One might stand 17 yrs.; 2, 16 yrs.; 2, 14 yrs.
14	Well charred	4	1	70	65	90	Two, 25 yrs.; 1 broken would have stood 17 yrs.; 2, 20 yrs. or more.
15	Crude oil 12 in. base...........	2	3	......	40	90	Two good for 20 yrs.; 1, 16 yrs.; 1, 15 yrs.; 1, 14 yrs.
16	Crude oil 12 in. and burned....	2	3	......	30	90	Two may last to 20 yrs.; 2 gone this year; 1 gone 2 yrs. ago.

Column 1 is the number of the set: column 2 states briefly the treatment; column 3 gives the number of posts which are whole, that is, have not been broken off through action of dry rot; column 4 gives the number which have been broken off; and from the appearance some estimation was made of the length of time these posts have been standing in the fence with the bottoms rotted off. The last three columns of the table give the condition of the posts at the bottom, at the ground surface, and weathering at the top, giving it in percentage. If the post was in perfect condition the mark will be 100 per cent; if entirely rotted off, so it would stand no longer in the fence, the percentage will be 0; if the estimation showed 50 per cent gone with dry rot, the condition would be 50 per cent, and so on. These figures give a comparative idea of the effects of different methods of treatment and of the life of the posts not treated. In the notes following each set of data in the tables an attempt is made to estimate the life of each post. In the cases where they have probably been rotted off for one or more years, the notes indicate that the life of the post was that much less than the length of time since the experiment was begun. On the other hand, if in the opinion of the observer the post would last a longer time, the total life of the post is indicated. For example, in the fourth set of posts it is estimated that one would last four years longer, and the notes state "one 20 years," indicating that the total life of the post would be 20 years. Two of these posts had been rotted off for four or five years, and the notes state that their life was about twelve years. In addition to the tabulated data, the following notes on each post are given to indicate the general condition:

First 5. Two and one-half feet of bottom dipped in tar. Post No. 1 rotted off near surface of the ground, about two feet two inches from the bottom. Bottom in good condition, showing no rot. Posts Nos. 2, 3, 4, and 5, all in fairly good condition; each one is just beginning to show the effects of

dry rot in a ring from twenty-two to twenty-seven inches from the bottom, which is the location of the surface of the ground.

Second 5. No treatment. Posts Nos. 1, 2, and 3 rotted off near the surface of the ground. No. 4 effected with dry rot from within six inches of the bottom to the ground surface, and would probably not last more than one year longer. Post No. 5 badly dry rotted from the bottom to the ground surface. Only No. 5, in this set, still holding the fence.

Third 5. Two and one-half feet of base dipped in crude oil. Post No. 1 showing a little dry rot from bottom to surface, increasing till about 10 per cent of the body of the post is affected at the ground surface. Posts Nos. 2 and 3 sound at bottom, but about 10 per cent of the body of post rotted off with dry rot in a ring eight to ten inches wide near the ground surface. Posts 4 and 5 practically in a perfect condition.

Fourth 5. Treated with tar band eighteen to thirty inches from base. Posts No. 1 and No. 5 in perfect condition. Posts Nos. 2 and 4 rotted squarely off near the ground surface. Post No. 3 dry rotted from bottom of post to above ground surface, about two-thirds gone.

Fifth 5. Band of petroleum eighteen to thirty inches from base. Post No. 1 almost in perfect condition, enough rot started to be noticed. Post No. 2 beginning to dry rot near surface of the ground; would probably last seven to ten years longer. Posts Nos. 3, 4, and 5 almost as good as new.

Sixth 5. *Crude oil two and one-half feet of base, burned off. Posts almost as good as new. No. 1 shows slight beginning of rot underneath the char, but the others are in perfect condition. If properly done, this treatment seemingly would make good posts last indefinitely.*

Seventh 5. Tarred two and one-half feet of base, and tar burned off. Post No. 1, one-half body of post rotted off near ground surface. Post No. 2, good as new. Post No. 3 about one-third rotted off near ground surface. Post No. 4 shows

general dry rot from bottom to the surface of the ground. Post No. 5, general dry rot from bottom to the surface of the ground.

Eighth 5. Crude oil band eighteen to thirty inches from bottom, burned off. Posts Nos. 1, 4, and 5 rotted through and broken squarely off an inch or two below the surface of the ground. Nos. 2 and 3, dry rotted from bottom to the surface, and near ground surface one-third to three-fourths gone.

Ninth 5. No treatment. Posts Nos. 1 and 3 show a little dry rot from the bottom to the ground surface. Posts Nos. 2 and 4, rotted three-fourths off. Post No. 5, rotted and broken squarely off at ground surface; apparently has been in this condition for several years.

Tenth 5. Tar band eighteen to thirty inches from bottom and burned off. Posts Nos. 1 and 3 rotted squarely off near surface. Post No. 4, four-fifths gone. Posts Nos. 1 and 5, dry rotted at the bottom, No. 5 being in fair condition near the surface of the ground.

Eleventh 5. Tar twelve inches of base. All five posts show very uniform condition, each being rotted about the same amount from the bottom of the post to the ground surface. This rotting is not large in amount, the maximum being about one-fourth of substance of post.

Twelfth 5. Tar twelve inches of the base and burned off. Post No. 1 in good condition, showing a little dry rot. Post No. 2, all of the part under ground effected with dry rot, being one-half to two-thirds gone. Posts Nos. 3 and 4, from one-fifth to two-thirds rotted away. Post No. 5, rotted and broken squarely off near the ground surface.

Thirteenth 5. No treatment. Post No. 1 rotted and broken off ten inches below the surface. Post No. 2, one-fourth rotted off. Posts Nos. 3 and 4, rotted and broken squarely off six inches below the surface. Post No. 5, rotted almost through from the surface to the bottom of the post; might last one year longer.

Fourteenth 5. Well charred. Posts Nos. 1 and 2 in fairly good condition, merely showing beginning of rot near the surface. Post No. 3 in good condition. Post No. 4 rotted and broken off one foot below the surface. Post No. 5 shows dry rot from the surface of the ground to the bottom of the post.

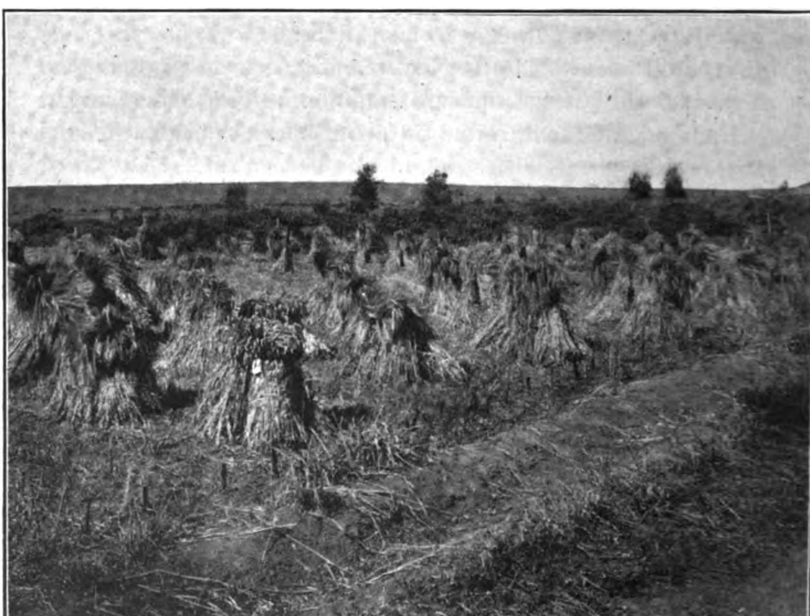
Fifteenth 5. Twelve inches of the base dipped in crude oil. Post No. 1, broken off and exchanged last year, was partly destroyed with rot. Post No. 2, broken off this year by accident, was in good condition. Post No. 3 rotted off at surface and changed last year. Post No. 4 in good condition. Post No. 5 rotted off five or six inches below the surface of the ground.

Sixteenth 5. Twelve inches of the base dipped in crude oil, and oil burned. Posts Nos. 1 and 2, dry rot beginning to show near the surface; in fair condition. Posts Nos. 3 and 4, on each side of canal, rotted off about one foot below the surface, or just above where the oil was burned off. Post No. 5, rotted off at surface.

Conclusion.—It will be noted that the treatment which has preserved these fence posts the best is dipping in crude oil and burning off the oil. This seems to drive the hot oil into the post and cover the outside with a char, a combination which is quite effectual against attacks of dry rot. Simply using the crude oil band near the surface of the ground gave almost as good results, and dipping the lower end of the posts to above ground surface in tar had the same effect. It is very clear that most of our post troubles is a dry rot which causes them to break off near or just below the surface of the ground. Dipping in crude oil and burning off the oil can be done very cheaply, and would undoubtedly pay anyone who is building permanent fence.

BARLEY EXPERIMENTS.

In the report of the Director I have indicated the co-operation which has been begun with the Department of Agriculture in our barley work. Last year Mr. Adolph Busch of St. Louis donated to the Experiment Station, to aid our barley experiments, $100. This money was used in the cropping experiments last season, a general report of which will be found in this volume made by the Agronomist. This barley work is of much importance, and the present season's work will, with data which is already accumulated, bring together information which can be used in publishing a Station bulletin on this subject.



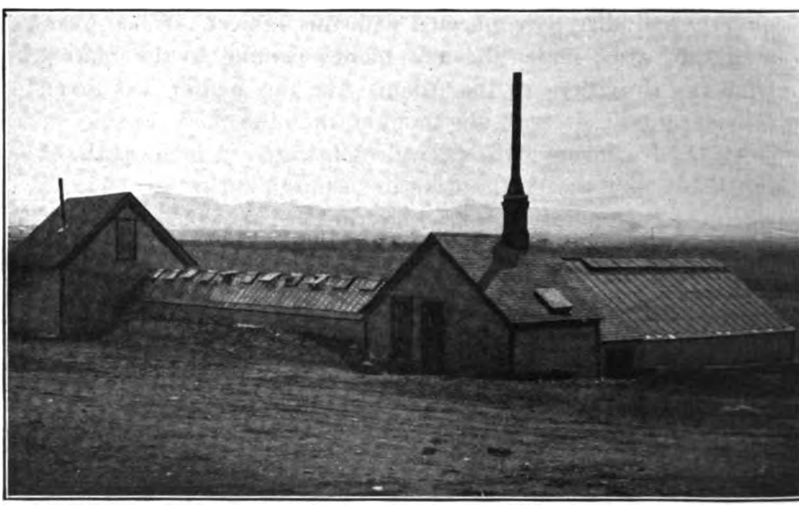
BARLEY IN STACKS.

Each bundle represents a different variety. Nearly every known kind of barley was planted here—some 315 varieties in all.

MOISTURE INVESTIGATIONS.

The subject of dry farming has been much in the public mind throughout the arid and semi-arid region for the past two or three years. In several places there have been established demonstration farms to determine, by direct field trials, whether or not crops can be made to grow on our soils and with our scanty rainfall. Enough has been done to demonstrate that, under proper conditions and with methods of cultivation to conserve moisture, certain crops will succeed. Some of the Experiment Stations have taken up more or less work directly or indirectly connected with this subject. When planning our work under the new money coming to the Station from the provisions of the Adams Act, this matter was given consideration. It was my thought that the mere raising of crops by dry farming has been demonstrated in many parts of the West, but that little accurate information is available in regard to the underlying principles of either the conservation of soil moisture or the actual use of that moisture by plants in the arid region. We have, therefore, taken up some technical studies of soil moisture and its use by plants, and in another part of this report will be found the field moisture studies carried out by Prof. H. T. Nowell. Parallel with the field work undertaken, I established some laboratory investigations which have been carried out in the Station greenhouse. For the purpose of these studies I designed a special pot made out of galvanized iron. This pot is six inches by eight inches in size, giving a soil surface of one-third of a square foot. Not only is the pot of convenient size for the growing of plants, but the area makes it a simple matter to compute duty of water, and apply fertilizers which will compare with the same items in the field. One set of these pots was made twenty-nine inches deep for the use of such deep rooted plants as alfalfa, and a set was made fourteen inches deep for the use of the more shallow rooted plants. They have a hole in the bottom in which a half-inch cork can be fitted, and this provides drainage in case

enough water was used to produce an accumulation of free water in the pot. One side of the pot is made so it can be removed, and a series of screens made of quarter-inch mesh wire was cut to fit the inside of the pots and fastened to wires hanging over the top, in order to hold the roots in position, so the soil could be washed out for studies of nodules on nitrogen-gathering plants. The first experiment carried out with these pots was one in which we expected to combine studies of the use of moisture and of the accumulation of nitrogen from the air in our western soil by legumes.



GREENHOUSE LABORATORY, USED IN MOISTURE INVESTIGATIONS.

I am indebted to Mr. J. A. Hill for doing the larger part of the manual work in beginning this experiment, and to Mr. Frank Smith, who has faithfully watered the pots each week, keeping notes and weights for over one-half of the year.

The first series of pots was planted on November 6, 1906. Twelve pots, fourteen inches deep, were planted to barley, and

twelve pots, twenty-nine inches deep, to alfalfa. A check pot, No. 24, was left unplanted, having been filled with soil from a rotation plat on the Experiment farm. The second series of pots was planted February 5, 1907. There were three check pots, each one filled with different soil and left without planting. These were No. 43, filled with soil which had been in alfalfa for more than ten years on the Station farm; No. 51, filled with soil from a plat on which a three years' rotation is conducted on the Station farm; and No. 59, filled with soil from the prairie, which has never been cultivated, and upon which native short grasses are the only vegetation. In the table these soils are indicated by letters, *Rot.*, meaning rotation; *Nat. Sod.*, meaning natural sod; *Alfal.*, meaning alfalfa soil. The rotation plat is one in which has been planted alternately a legume, a root crop, and a small grain, for the past ten years, having been in field pease the last season. To some of these pots also were added well rotted barnyard manure at the rate of one pound to the pot, or approximately sixty-five tons per acre. To another series was added three-fourths of a gram of sodium phosphate, or approximately at the rate of 200 pounds per acre. It was the intention to add to the series also some nitrate of soda, but this was left out in the first test and may be done in the future work. The following tables, Nos. I to XII, give the results computed at the end of this year:

TABLE I—BARLEY.

Planted November 6, 1906; Harvested June 26, 1907.

WEEK ENDING	Pot No. 1	Pot No. 2	Pot No. 3	Pot No. 4	Pot No. 5	Pot No. 6	Pot No. 7	Pot No. 8	Pot No. 9	Pot No. 10	Pot No. 11	Pot No. 25	Pot No. 24
	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
November 6	3 0	3 0	3 0	3 1	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	5 0
November 22	1 6	1 10	1 14	2 1	0 12	1 0	1 7	1 1	1 5	0 13	2 0	1 0	1 8
December 1	3 0	1 4	1 3	2 5	0 15	1 2	1 3	0 12	1 2	0 14	1 4	2 9	0 13
December 8	1 4	0 15	0 12	0 12	0 12	0 14	0 14	0 12	0 13	0 11	0 15	1 2	0 10
December 15	1 1	1 2	1 9	1 3	0 15	1 2	1 3	0 15	1 0	0 14	1 10	1 2	0 14
December 22	1 0	1 2	1 1	1 1	0 13	0 15	0 13	0 12	0 14	0 12	0 15	1 0	1 2
January 8	2 0	2 4	2 7	3 3	1 10	3 2	2 4	2 1	2 5	1 9	2 10	3 5	2 7
January 16	1 2	1 11	1 12	1 12	1 7	1 10	1 13	1 9	1 13	1 7	2 4	3 0	1 1
January 21	1 3	2 13	2 1	2 11	1 8	2 13	1 15	1 11	1 14	1 5	2 4	5 1	1 13
January 29	1 4	1 12	1 15	1 12	1 9	1 15	1 15	1 9	2 0	1 7	2 7	3 11	0 14
February 5	4 14	4 1	4 3	5 0	4 2	5 12	6 1	3 8	6 12	5 10	7 10	7 13	3 10
February 12	3 4	4 7	3 12	4 5	3 0	4 8	4 5	3 4	5 0	4 4	5 15	7 3	0 0
February 18	4 14	4 5	4 6	5 0	4 15	5 15	6 1	3 12	6 11	4 14	7 9	8 8	0 0
February 26	4 15	4 2	3 15	4 13	4 0	5 4	4 11	3 10	6 5	4 14	7 7	7 13	0 0
March 5	4 11	4 9	4 1	4 8	3 15	5 10	6 4	3 9	6 8	4 13	7 5	7 11	0 4
March 12	5 3	3 15	4 5	4 15	4 3	5 13	5 14	3 13	6 11	5 2	7 11	7 2	0 0
March 19	6 1	5 5	6 15	5 3	4 5	5 13	6·0	4 7	6 15	5 7	7 15	8 4	1 2
March 27	6 0	4 1	3 15	5 13	4 12	6 3	6 7	4 8	7 9	6 0	8 9	8 14	0 8
April 3	5 9	4 2	4 6	4 13	4 4	4 9	4 5	3 12	6 15	5 6	7 3	7 9	1 0
April 9	5 8	3 15	4 0	4 8	3 15	4 4	3 2	3 11	6 7	5 4	6 14	7 13	0 0
April 15	5 9	4 2	4 1	4 11	3 12	3 14	3 4	3 10	6 3	5 1	7 1	7 11	0 0
April 22	5 6	3 10	3 9	4 2	3 9	3 9	3 2	3 0	6 4	5 5	7 3	8 0	1 6
May 1	4 2	2 10	2 5	3 0	2 2	2 12	2 8	2 1	5 9	5 1	6 9	7 7	0 0
May 7	2 11	1 12	1 6	2 6	1 7	1 15	1 12	1 4	5 11	5 1	5 15	7 1	0 2
May 14	1 13	1 7	1 2	2 2	2 4	1 14	1 10	1 2	5 14	5 1	5 1	6 9	0 6
May 21	1 5	1 2	1 1	1 10	1 1	1 10	1 14	1 2	6 3	5 1	5 5	7 2	0 6
May 29	0 10	0 9	0 10	0 13	0 8	0 15	1 3	0 11	3 4	4 0	2 15	4 0	0 5
June 5	0 11	0 13	0 12	0 14	0 14	0 15	1 4	0 12	4 5	4 12	3 5	4 4	0 7
June 12	1 5	1 4	1 5	1 11	1 6	1 4	2 0	1 6	5 12	4 15	3 8	5 3	0 8
June 19	1 13	1 10	2 0	2 12	1 8	1 10	2 7	1 12	6 12	5 10	4 6	5 10	0 10
June 26	1 6	1 2	1 6	1 5	0 12	1 1	1 10	0 14	3 5	2 10	2 13	4 0	0 3
Totals	93 14	80 8	80 10	94 1	73 15	92 11	92 3	69 10	141 1	116 15	147 8	170 2	27 4
Weight of crop	0 2	0 1.75	0 2.25	0 2.75	0 2	0 1.75	0 2	0 1.5	0 8	0 6	0 6.5	0 7.5	0 0

TABLE II—BARLEY.

Planted November 6, 1906; Harvested June 26, 1907; 31 weeks.

No. of pot	No. plants	No. stems	No. heads	Highest stem, in.	Average height, in.	Weight of crop, oz.	Kind of soil	Water used, ft.	REMARKS
1	3	14	12	40	......	2.0	Rot	4.51	Straw ripe.
2	3	12	11	40	32	1.75	Rot	3.86	Straw ripe.
3	2	13	11	43	34	2.25	Rot. & P.........	3.87	Heads fully ripe; some straw green.
4	3	20	14	39	30	2.75	Rot. & P.........	4.51	Straw ripe; some second growth.
5	3	15	10	30	28	2.0	Alk.	4.55	Five green stems; second growth.
6	3	20	15	32	30	1.75	Alk.	4.15	Straw ripe.
7	3	20	15	......	35	2.0	Alk. & P.........	4.42	Straw ripe.
8	3	13	7	36	28	1.5	Alk. & P.........	3.34	Straw ripe; some aborted heads.
9	3	84	64	43	29	8.0	Alk. & Man.....	8.77	Seven smutted heads; not all ripe.
10	3	65	44	34	30	6.0	Rot. & Man.....	5.61	One-half full ripe; rest mature heads.
11	3	56	34	36	30	6.5	Alk. & Man.....	7.09	Seven stems second growth, green.
24*	......	......	......	......	......	....	Rot	1.31	This pot 29 inches deep.
25	3	70	50	36	32	7.5	Rot. & Man.....	3.17	Some second growth, green; two smut heads.

*Check; pot without plants.
Rot.—Rotation soil.
Rot. & P.—Rotation soil with sodium phosphate added.
Alk.—Alkali soil from Plat 2, Experiment Station Farm.
Alk. & Man.—Alkali soil and manure.

TABLE III—ALFALFA.

Pots 6x8, 29 inches deep. Planted November 7, 1906; Harvested June 26, 1907.

WEEK ENDING	Pot No. 12	Pot No. 13	Pot No. 14	Pot No. 15	Pot No. 16	Pot No. 17	Pot No. 18	Pot No. 19	Pot No. 20	Pot No. 21	Pot No. 22	Pot No. 23	Pot No. 24
	lbs. oz	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
November 6	5 10	5 7	5 9	5 2	5 0	5 0	5 0	5 0	5 0	5 0	5 0	5 0	5 0
November 22	8 8	4 4	4 10	4 7	2 6	2 2	0 0	2 5	5 4	4 7	4 8	2 18	1 8
December 1	1 1	1 3	1 3	1 3	1 2	1 3	0 12	1 5	2 6	1 6	1 4	1 4	0 13
December 8	0 11	0 13	0 12	0 12	0 12	0 12	0 0	0 15	1 0	0 14	0 12	0 14	0 10
December 15	1 0	1 1	1 3	1 0	1 2	1 3	0 0	1 6	1 8	1 4	1 2	1 2	0 14
December 22	0 14	1 0	1 0	1 2	1 4	1 5	0 2	1 4	1 9	1 6	1 7	1 10	1 2
January 8	1 2	1 3	1 7	1 3	1 5	1 5	0 2	1 10	1 10	1 14	1 9	1 11	2 7
January 16	0 14	0 13	0 14	0 12	0 9	0 8	4 8	0 15	1 2	1 12	1 2	1 2	1 1
January 21	0 13	0 11	0 14	0 12	0 10	0 6	0 2	0 9	1 0	1 5	1 0	0 14	1 13
January 29	0 11	0 10	0 11	0 9	0 8	0 4	0 0	0 7	0 10	1 1	0 12	0 12	0 14
February 5	8 9	5 1	7 1	5 11	4 7	5 8	3 8	5 2	2 12	5 0	5 9	4 12	3 10
February 12	8 8	1 9	2 3	2 0	1 9	1 11	2 1	2 14	1 14	2 8	1 15	0 6	0 0
February 18	3 10	1 10	1 10	1 1	1 3	1 5	2 5	1 14	1 2	2 3	1 10	1 8	0 0
February 26	3 12	1 6	2 2	1 7	1 0	1 8	1 14	1 7	1 5	0 0	1 6	0 0	0 0
March 5	4 8	1 10	2 2	1 6	0 10	1 1	3 14	1 4	1 2	2 10	1 10	2 4	0 4
March 12	5 10	1 13	2 11	1 9	1 10	1 2	2 0	1 6	1 5	1 14	1 10	1 7	0 0
March 19	8 3	2 9	3 8	1 12	1 11	1 2	2 0	1 3	1 13	2 2	1 13	1 11	1 2
March 27	12 0	2 10	4 9	2 4	0 10	1 10	0 8	1 5	1 12	2 9	2 4	2 1	0 8
April 3	11 2	3 7	4 14	2 10	1 6	1 [illegible]	2 11	1 6	3 4	2 8	2 5	2 5	1 0
April 9	12 11	4 15	5 15	3 5	1 7	2 6	2 6	1 5	4 8	2 10	3 0	2 9	0 0
April 15	12 14	6 4	7 12	4 9	1 15	3 14	3 4	1 9	8 2	3 12	4 7	3 6	0 0
April 22	12 11	8 4	8 9	4 12	2 5	4 2	2 2	1 8	5 15	4 6	4 14	4 0	1 6
May 1	12 11	7 12	9 15	5 0	2 8	4 8	3 4	1 6	5 8	3 12	4 12	3 14	0 0
May 7	10 9	6 14	13 0	3 15	2 1	4 8	3 3	1 2	5 12	4 0	4 15	4 2	0 2
May 14	12 6	8 6	11 5	5 12	2 13	6 4	4 0	1 7	6 12	4 7	5 11	4 8	0 6
May 21	12 10	9 7	10 11	6 15	4 0	8 10	6 4	1 11	8 0	6 15	8 8	6 15	0 6
May 29	6 0	4 13	6 6	3 13	3 3	5 2	4 0	0 15	4 4	3 12	4 10	8 6	0 5
June 5	10 10	7 15	8 2	6 [illegible]	4 1	7 8	6 12	1 6	7 9	6 8	10 2	5 14	0 7
June 12	12 14	9 8	11 12	8 [illegible]	6 1	9 12	9 12	2 6	6 8	8 5	10 5	8 5	0 8
June 19	13 12	10 4	13 5	11 8	9 2	10 13	12 2	4 5	9 5	10 8	11 11	9 15	0 10
June 26	10 7	7 14	8 6	8 12	6 9	6 6	5 0	3 13	4 4	7 14	5 12	6 11	0 8
Total	216 0	131 0	164 0	109 3	[illegible] 13	104 1	94 8	56 1	113 13	108 8	117 5	97 1	27 4
Weight of crop	0 9	0 5.5	0 5	0 6	[illegible] 3	0 4	0 3.25	0 1.5	0 4	0 4	0 4	0 8	0 0

TABLE IV—ALFALFA.

Twenty-nine-inch Pots. Planted November 7, 1906; Harvested June 26, 1907.

No. of pot	No. plants	No. stems	Highest stem, in.	Average height, in.	Weight green plants, oz.	Kind of soil	Water used, ft.	REMARKS
12	2	86	42	26	9.0	Rot. & Man......	10.37	Full bloom and seed pods.
13	2	53	44	24	5.5	Rot.	6.29	In bloom; larger stems with seed pods.
14	2	48	42	28	5.0	Alfalfa	7.87	In bloom; no seed pods.
15	1	31	46	27	6.0	Alfalfa	5.24	Full bloom, with seed pods.
16	2	14	39	32	3 0	Rot.	3.58	Full bloom; beginning to form seed pods.
17	3	25	37	30	4.0	Rot.	4.99	Full bloom; some seed pods formed.
18	2	34	40	24	3.25	Rot.	4.54	In bloom; no seed pods.
19	1	14	38	24	1.5	Rot.	2.69	Just beginning to bloom.
20	3	33	40	28	4.0	Nat. Sod.........	5.46	Full bloom; few seed pods.
21	3	31	40	32	4.0	Nat. Sod.........	5.19	Beginning to bloom.
22	3	28	50	30	4.0	Nat. Sod.........	5.63	In full bloom.
23	2	39	37	25	3.0	Rot.	4.66	Beginning to bloom.
24*	.....	......	......	......	....	Rot.	1.31	

*Check; pot without plants.

TABLE V—CANADA FIELD PEASE.

Planted February 5, 1907; Harvested June 26, 1907.

WEEK ENDING	Pot No. 26	Pot No. 27	Pot No. 28	Pot No. 30	Pot No. 31	Pot No. 32	Pot No. 34	Pot No. 35	Pot No. 36	Pot No. 48	Pot No. 51	Pot No. 59
	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
February 5	4 11	4 5	4 5	1 2	1 15	1 14	4 13	4 13	2 9	3 5	3 0	4 10
February 12	1 3	1 2	0 15	0 6	1 0	0 11	1 5	3 4	0 15	1 2	0 14	1 6
February 18	1 0	1 15	0 13	2 0	0 12	0 5	0 14	1 15	0 10	0 13	0 6	1 2
February 26	0 13	0 13	1 1	0 13	0 12	0 7	0 15	0 14	0 12	0 13	0 10	0 15
March 5	0 14	0 14	1 2	0 14	0 13	0 9	0 13	0 14	0 13	0 10	0 8	0 15
March 12	1 0	0 13	1 6	0 12	0 15	0 9	0 15	1 0	1 4	0 15	0 11	0 15
March 19	1 2	1 2	2 0	1 5	1 5	1 0	1 0	1 6	1 7	0 12	0 9	1 4
March 27	1 11	1 7	2 12	1 10	1 7	1 9	1 8	1 8	1 14	1 0	0 13	1 6
April 3	1 2	1 4	2 1	1 6	1 5	1 6	1 3	1 8	1 13	1 0	1 0	1 3
April 9	1 13	1 9	2 9	2 0	1 13	1 12	1 11	1 11	1 13	0 9	0 4	1 3
April 15	2 10	1 15	2 14	2 5	2 1	2 0	2 6	2 8	2 2	0 9	0 7	1 4
April 22	2 10	2 2	2 13	0 11	2 2	2 0	2 9	2 6	2 3	0 11	0 7	1 0
May 1	2 8	1 15	2 9	2 5	2 2	1 15	2 8	2 8	2 1	0 10	0 7	1 0
May 7	2 8	2 1	2 10	1 12	1 14	1 12	2 8	2 1	2 0	0 8	0 6	0 15
May 14	2 10	2 1	2 11	1 15	1 13	1 12	2 7	2 6	1 12	0 7	0 4	0 12
May 21	2 15	2 7	2 14	2 5	2 4	1 15	2 9	3 9	2 2	0 8	0 5	1 1
May 29	1 11	1 2	2 0	1 3	0 8	0 15	1 12	1 0	1 8	0 5	0 3	0 7
June 5	2 13	2 3	2 10	2 4	1 12	1 11	2 10	2 4	2 0	0 6	0 2	0 14
June 12	2 15	2 8	2 15	2 5	1 9	1 13	2 14	2 5	2 1	0 6	0 3	0 15
June 19	3 5	2 14	3 2	2 8	2 9	2 5	3 2	3 3	2 7	0 9	0 4	1 3
June 26	2 15	2 10	2 15	2 8	1 14	2 1	2 14	2 13	1 15	0 10	0 5	1 6
Totals	44 13	39 2	49 1	34 5	32 9	30 5	43 4	45 12	36 1	16 8	12 0	25 12
Weight of crop	0 4.5	0 3.5	0 5.5	0 2.5	0 3	0 4	0 4	0 4.5	0 5.5	0 0	0 0	0 0

TABLE VI—CANADA FIELD PEASE.

Planted February 5, 1907; Harvested June 26, 1907.

No. of pot	No. plants	No. stems	Highest stem, in.	Average height, in.	Weight green crop, oz.	Kind of soil	Water used, ft.	REMARKS
26	3	3	53	53	4.5	Rot.	2.15	Beginning to bloom; upper portion of stems thickened.
27	3	4	50	50	3.5	Rot.	1.88	Seven pods of green peas formed.
28	4	11	43	28	5.5	Rot. & Man.	2.45	Four pods of green peas.
30	4	5	72	55	3.5	Nat. Sod	1.65	Six pods of green peas; soil surface 3 in. below top of pot.
31	4	4	53	48	3.0	Nat. Sod	1.56	Four pods green peas.
32	4	7	41	36	4.0	Nat. Sod. & Man.	1.45	Nine pods with green peas.
34	3	6	56	......	4.0	Alfalfa	2.08	Fourteen green pea pods.
35	2	......	57	50	4.5	Alfalfa	2.20	Beginning to bloom; thickened at tops.
36	4	10	39	80	5.5	Alfalfa & Man.	1.73	Five pods green peas, well filled.
43*	......	......	......	......	......	Alfalfa	0.79	
51*	......	......	......	......	......	Rot.	0.58	
59*	......	......	......	......	......	Nat. Sod	1.24	

*Check; not planted.

TABLE VII—ALFALFA.

In Pots 6x8, 14 Inches Deep. Planted February 5, 1907; Harvested June 26, 1907.

WEEK ENDING	Pot No. 40	Pot No. 41	Pot No. 42	Pot No. 43	Pot No. 48	Pot No. 49	Pot No. 50	Pot No. 51	Pot No. 56	Pot No. 57	Pot No. 58	Pot No. 59
	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
February 5	3 2	3 5	3 6	3 5	3 4	3 3	3 6	3 0	3 12	3 14	4 15	4 10
February 12	1 4	1 3	0 9	1 2	1 8	1 10	0 9	0 14	1 3	1 4	0 14	1 6
February 18	1 0	0 14	0 5	0 13	0 13	0 13	0 8	0 6	1 2	0 14	0 9	1 2
February 26	0 14	0 14	0 4	0 13	0 14	1 0	0 6	0 10	0 15	0 14	0 8	0 15
March 5	0 12	0 12	0 7	0 10	0 14	0 11	0 6	0 8	0 15	0 13	0 8	0 15
March 12	0 14	0 14	2 0	0 15	0 13	0 13	0 5	0 11	0 13	0 15	0 8	0 15
March 19	0 14	1 13	0 11	0 12	1 0	0 15	1 5	0 9	1 6	1 2	0 12	1 4
March 27	0 15	1 1	1 8	1 0	1 3	1 4	1 8	0 13	1 0	1 3	0 11	1 6
April 3	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 3
April 9	1 8	1 11	1 0	0 9	0 10	0 14	1 0	0 4	1 1	1 0	0 13	1 3
April 15	0 1	1 0	0 0	0 9	0 14	0 13	0 0	0 7	1 3	1 0	2 0	1 4
April 22	0 13	0 0	2 2	0 11	0 14	0 13	2 0	0 7	1 4	1 2	2 14	1 0
May 1	0 15	1 8	2 12	0 10	1 1	0 14	2 7	0 7	1 2	1 1	2 15	1 0
May 7	0 14	0 2	3 5	0 8	0 14	0 13	2 13	0 6	1 3	1 0	3 4	0 15
May 14	0 14	0 12	3 14	0 7	1 2	0 13	3 1	0 4	1 10	1 3	3 10	0 12
May 21	1 5	1 12	4 4	0 8	1 11	1 6	3 6	0 5	2 7	2 1	3 13	1 1
May 29	0 12	0 15	3 4	0 5	0 15	0 11	1 14	0 3	1 3	0 15	2 8	0 7
June 5	1 0	1 14	3 11	0 6	1 13	1 8	3 3	0 2	2 4	1 14	3 14	0 14
June 12	2 3	2 7	4 4	0 6	2 13	2 0	3 7	0 3	3 6	3 0	4 0	0 15
June 19	3 2	3 4	4 9	0 9	3 7	3 2	2 11	0 4	3 12	3 8	4 3	1 3
June 26	2 7	2 13	4 6	0 10	3 3	3 2	3 10	0 5	3 11	3 7	4 3	1 6
Totals	26 10	29 14	46 9	16 8	30 5	27 13	33 13	12 0	36 4	33 2	48 6	25 12
Weight of crop	0 1.5	0 1.25	0 2	0 0	0 1	0 0.75	0 1.75	0 0	0 1.25	0 1.25	0 2	0 0

TABLE VIII—ALFALFA.

In 14-inch Pots, 6x8 Surface. Planted February 5, 1907; Harvested June 26, 1907.

No. of pot	No. plants	No. stems	Highest stem, in.	Average height, in.	Weight green, oz.	Kind of soil	Water used, ft.	REMARKS
40	9	26	28	20	1.5	Alfalfa	1.29	Upper leaves blistered.
41	5	17	29	25	1.25	Alfalfa	1.43	Budded to bloom.
42	5	21	32	23	2.0	Alfalfa & Man.	2.25	In full bloom.
43*	.....	.....	.....	.....	.....	Alfalfa	0.79	
48	5	19	27	18	1.0	Rot.	1.45	Beginning to bloom.
49	4	18	26	23	0.75	Rot.	1.33	Budded to bloom.
50	5	30	26	22	1.75	Rot. & Man.	1.86	In bloom; wilting.
51*	.....	.....	.....	.....	.....	Rot.	0.58	
56	4	19	36	25	1.25	Nat. Sod.	1.74	In bloom.
57	3	16	37	24	1.25	Nat. Sod.	1.59	Budded to bloom.
58	4	32	32	24	2.0	Nat. Sod. & Man.	2.32	In bloom; wilting.
59*	.....	.....	.....	.....	.....	Nat. Sod.	1.24	

*Check.

TABLE IX—BOKHARA CLOVER.

Planted February 5, 1907; Harvested June 26, 1907.

WEEK ENDING	Pot No. 29	Pot No. 33	Pot No. 37	Pot No. 38	Pot No. 39	Pot No. 43	Pot No. 46	Pot No. 47	Pot No. 51	Pot No. 54	Pot No. 55	Pot No. 59
	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
February 5	4 11	1 14	2 3	2 14	3 2	3 5	3 4	2 14	3 0	3 11	3 14	4 10
February 12	1 4	1 2	1 5	1 2	0 7	1 2	1 2	1 12	0 14	1 4	0 11	1 6
February 18	1 0	0 13	0 14	0 15	0 5	0 13	1 0	0 6	0 6	1 0	0 5	1 2
February 26	1 0	0 15	0 14	0 14	0 6	0 13	0 14	0 6	0 10	0 15	0 3	0 15
March 5	0 13	0 11	0 12	0 13	0 6	0 10	0 13	1 0	0 8	0 13	0 5	0 15
March 12	0 13	0 11	0 12	0 14	2 11	0 15	1 0	1 2	0 11	0 14	0 7	0 15
March 19	0 15	0 11	0 14	1 15	0 9	0 12	1 0	1 0	0 9	0 15	1 0	1 4
March 27	1 2	0 14	2 1	0 14	1 8	1 0	1 3	1 8	0 13	0 14	1 8	1 6
April 3	1 1	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 8
April 9	0 15	0 6	0 9	1 8	1 0	0 9	0 13	1 0	0 4	1 12	0 0	1 3
April 15	0 14	0 8	0 10	0 0	0 0	0 9	0 13	0 0	0 7	0 14	0 0	1 [illegible]
April 22	1 0	0 7	0 10	1 5	0 0	0 11	0 13	0 0	0 7	0 10	0 0	1 [illegible]
May 1	0 13	0 6	0 10	0 0	0 0	0 10	0 13	0 0	0 7	0 11	0 0	1 0
May 7	0 13	0 6	0 10	0 5	2 6	0 8	0 12	0 0	0 6	0 12	0 0	0 15
May 14	0 11	0 5	0 9	0 5	0 0	0 7	0 12	0 0	0 4	0 11	0 8	0 12
May 21	1 8	2 6	1 10	1 5	1 2	0 8	0 11	1 4	0 5	0 12	1 1	1 1
May 29	0 12	0 0	0 0	0 0	1 2	0 5	0 8	0 0	0 3	0 7	0 10	0 7
June 5	1 4	0 0	0 4	0 0	1 14	0 6	0 14	1 0	0 2	0 11	1 9	0 14
June 12	1 13	0 5	0 8	0 13	2 8	0 6	1 0	0 12	0 3	1 0	2 8	0 15
June 19	3 3	0 14	1 9	2 9	3 0	0 9	2 9	1 10	0 4	1 9	1 5	1 3
June 26	3 1	1 4	1 12	0 11	2 12	0 10	2 13	2 8	0 5	2 4	1 7	1 6
Totals	29 1	15 14	20 0	20 3	26 2	16 8	24 7	18 2	12 0	23 7	22 5	25 12
Weight of crop	0 1	0 0.2	0 0.25	0 0.5	0 1.5	0 0	0 0.5	0 0.5	0 0	0 0.25	0 1	0 0

TABLE X—BOKHARA CLOVER.

Planted February 5, 1907; Harvested June 26, 1907.

No. of pot	No. plants	No. stems	Highest stem, in.	Average height, in.	Weight green, oz.	Kind of soil	Water used, ft.	REMARKS
29	4	17	13	10	1.0	Rot.	1.39	
33	2	3	5	4	0.2	Nat. Sod	0.76	Very small growth.
37	2	4	11	10	0.25	Alfalfa	0.96	
38	2	4	20	12	0.5	Alfalfa	0.97	
39	2	5	......	8	1.5	Alfalfa & Man.	1.25	One plant with only bunch of radical leaves.
43*	......	......	......	......	......	Alfalfa	0.79	
46	3	9	10	8	0.5	Rot.	1.17	
47	2	6	13	10	0.5	Rot. & Man.	0.87	
51*	......	......	......	......	......	Rot.	0.58	
54	1	5	10	7	0.25	Nat. Sod	1.12	
55	3	16	13	11	1.0	Nat. Sod. & Man.	1.07	Yellow flowered.
59*	......	......	......	......	......	Nat. Sod	1.24	

*Check.

	TABLE XI—BROME GRASS. Planted February 5, 1907; Harvested June 26, 1907.						WHEAT GRASS. Planted February 5, 1907; Harvested June 26, 1907.					
	Pot No. 43	Pot No. 44	Pot No. 51	Pot No. 52	Pot No. 59	Pot No. 60	Pot No. 43	Pot No. 45	Pot No. 51	Pot No. 53	Pot No. 59	Pot No. 61
	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
February 5	3 5	3 7	3 0	3 0	4 10	4 9	3 5	3 12	3 0	3 3	4 10	4 8
February 12	1 2	1 1	0 14	1 3	1 6	1 5	1 2	1 4	0 14	1 3	1 6	1 7
February 18	0 13	0 15	0 6	1 2	1 2	1 2	0 13	0 14	0 6	0 14	1 2	1 1
February 26	0 13	0 13	0 10	1 0	0 15	1 0	0 13	0 12	0 10	0 14	0 15	1 0
March 5	0 10	0 12	0 8	0 13	0 15	0 15	0 10	0 12	0 8	0 13	0 15	0 15
March 12	0 15	0 14	0 11	0 15	0 15	0 14	0 15	0 13	0 11	1 0	0 15	0 14
March 19	0 12	1 1	0 9	1 1	1 4	1 4	0 12	0 15	0 9	1 3	1 4	1 2
March 27	1 0	1 5	0 13	1 3	1 6	1 3	1 0	1 2	0 13	1 3	1 6	1 3
April 3	1 0	1 0	1 0	1 0	1 3	1 0	1 0	1 0	1 0	1 0	1 3	1 2
April 9	0 9	1 9	0 4	1 2	1 3	1 12	0 9	1 0	0 4	1 2	1 3	1 4
April 15	0 9	2 3	0 7	1 10	1 4	2 3	0 9	1 2	0 7	1 4	1 4	1 8
April 22	0 11	2 10	0 7	2 0	1 0	2 13	0 11	1 11	0 7	1 9	1 0	1 12
May 1	0 10	2 13	0 7	2 2	1 0	2 13	0 10	1 15	0 7	1 13	1 0	1 13
May 7	0 8	2 8	0 6	2 0	0 15	2 9	0 8	2 2	0 6	1 13	0 15	1 15
May 14	0 7	2 10	0 4	2 5	0 12	2 10	0 7	2 9	0 4	2 5	0 12	2 10
May 21	0 8	3 0	0 5	2 13	1 1	4 13	0 8	3 2	0 5	3 0	1 1	3 6
May 29	0 5	1 9	0 3	1 6	0 7	1 6	0 5	1 11	0 3	1 8	0 7	1 8
June 5	0 6	2 12	0 2	1 10	0 14	2 7	0 6	3 4	0 2	2 9	0 14	2 9
June 12	0 6	3 0	0 7	2 14	0 15	3 0	0 6	3 4	0 3	3 3	0 15	3 5
June 19	0 9	3 5	0 4	3 5	1 3	3 10	0 9	3 8	0 4	3 6	1 8	3 10
June 26	0 10	3 8	0 5	3 5	1 6	3 6	0 10	3 8	0 5	3 7	1 6	3 10
Totals	16 8	42 6	12 0	37 13	25 12	47 4	16 8	40 0	12 0	38 4	25 12	42 2
Weight of crop	0 0	0 1	0 0	0 0.75	0 0	0 0.5	0 0	0 1.25	0 0	0 1	0 0	0 0.5

TABLE XII—BROME GRASS.

Planted February 5, 1907; Harvested June 26, 1907. Pots 6x8 inches, 14 inches deep.

No. of pot	No. stools	Highest leaves, in.	Average height, in.	Weight green, oz.	Kind of soil	Water used, ft.	REMARKS
44	6	17	10	1.0	Alfalfa	2.03	Has produced only radical leaves.
43*	....	....	....	....	Alfalfa	0.79	
51*	....	....	....	....	Rot.	0.58	
52	6	14	10	0.75	Rot.	1.81	
59*	....	....	....	....	Nat. Sod	1 24	
60	5	8	8	0.5	Nat. Sod	2.27	

*Check.

WHEAT GRASS.

No. of pot	No. stools	Highest leaves, in.	Average height, in.	Weight green, oz.	Kind of soil	Water used, ft.	REMARKS
45	4	15	11	1.25	Alfalfa	1.92	Only radical leaves; some leaves dead.
43*	....	....	....	....	Alfalfa	0.79	
51*	....	....	....	....	Rot.	0.58	
53	6	12	8	1.0	Rot.	1.84	Only radical leaves; some leaves dead.
59*	....	....	....	....	Nat. Sod	1.24	
61	4	15	9	0.5	Nat. Sod	2.02	

*Check.

The water added to each pot each week is given in pounds and ounces, and with the growth of the plants the increase in the amount of water used is apparent. The evaporation of water from the soil seems to differ greatly with the soil, as will be noted by the different amounts evaporated from the check pots. Check pot 24 cannot be compared with the others, because it is twenty-nine inches deep, while the others are only fourteen inches deep, and they were not noted for the same length of time. It would seem that our natural prairie soil, which is not cultivated, loses water more readily by evaporation than do the cultivated soils, which may be due to its state of tilth, in part, and in part to the amount of humus which it contains. In some of the tables there seems to be carried out a rather definite proportion between the amount of crop due to the difference in richness of the soil, and the amount of water used.

With the limited data at hand, it is impossible to draw conclusions, but the accumulation of this kind of data will undoubtedly result in time in the discovery of some of the underlying principles of the conservation of moisture in our soils, and of the associated use of this moisture by the crop. Such information will be of the highest practical value, because it will give intelligent reasons for farm operations, and also throw light on the characters which it is desirable to breed into our crop plants to make them drouth resistant. It is already evident that a large crop, or one which exposes large leaf surfaces to the action of the air will require more moisture than a small crop, and the reason for thin sowing in places where moisture is scarce is very apparent.

WHITE SWEET CLOVER.

Some experiments were begun in 1894 with growing white sweet clover for a stock food. Two lines of work were contemplated. First we had in view breeding the sweet clover, in order to produce a plant which did not have the disagreeable

flavor and sweet scent which makes it unpalatable to many kinds of stock, and second, to change the plant, if possible, from a biennial to a perennial. This clover has long been considered a weed pest, but in my opinion it is destined to become a very important crop plant and forage. It is the hardiest clover we have ever tried, growing on any kind of soil, even that which has become strongly alkalized, or on dry upland without irrigation. The second line of investigations with this crop was to carry out feeding experiments, first curing the hay in such a way as would make it most palatable. Four acres on the lower end of the farm, including plats one, two, eleven, and twelve, were sown. This land had become alkalized and would grow no other profitable crop, unless it be of dwarf rape. The season of 1905 these plats gave the following yields:

WHITE SWEET CLOVER ON ACRE PLAT 12.

Plats one and two were only partially cut, the area being approximately one acre. The first cutting was made July 10th, and gave a total of 4,700 pounds of cured hay, or two and one-third tons per acre. This was cut the second time on August 24th, giving a total of 4,260 pounds, or two and one-tenth tons per acre. This gave a yield for the season of 8,960 pounds, or about four and one-half tons. Plats eleven and twelve consisted of two acres. The first cutting was made July 10th, and produced 6,460 pounds cured hay. The second cutting was made August 24, and produced 8,504 pounds. The total

for the season was 14,964 pounds, or three and seventy-five hundredths tons per acre. Plats one and two had not been irrigated and plat eleven was irrigated for the second crop. Each cutting was stacked in two small stacks, one of them having a quantity of stock salt sprinkled on the hay when put in the stack. The breeding experiments have given no results except the possibility of greatly improving the plant.

The feeding experiments have given some important data. Published herewith is a half-tone picture of the carcass of a lamb fed on white sweet clover hay, and corn, with the carcass of a lamb fed on native hay and corn. Mr. Morton expects to publish this data in a forthcoming bulletin. The lambs seem to eat the hay as well as they would any, at first seeming to prefer it to alfalfa, and it is probable that any stock can be taught to eat good sweet clover hay if properly cured.

An analysis made by our Chemist showed a total of 22 per cent protein in one sample of this hay. This is the highest protein percentage shown by any of our forage crops, and would indicate a richness of the plant which would make it necessary to feed with caution in order not to give so much that the animals would lose their appetite, and "go off feed."

FLAX.

For many years our Station has grown flax, and attention is called to lamb feeding bulletins of previous years, which give the results of feeding the flaxseed with hay and root crops to fattening lambs. The Experiment Station took a medal and diploma on flax exhibited at the Columbian Exposition at Chicago in 1893. In 1894 new Russian flax on the Station farm produced 15.6 bushels of seed per acre. In 1897 a yield was obtained of 16.4 bushels per acre. The success of these previous trials encouraged us to accept the co-operation of the United States Department of Agriculture, Bureau of Plant Introduction, in 1905, and eight varieties which had been obtained through the work of Prof. Bolley of North Dakota were

COMPARING LAMB CARCASS FED SWEET CLOVER AND ONE FED NATIVE HAY.

planted. The flax did well, but it was harvested very late, and much of the seed shelled out and was left on the ground, so yields are of no value except in a comparative way to compare the different varieties. There has been little interest in the subject among our people and the trials were not continued. The following results were obtained. The numbers indicate the varieties, as named by the Department of Agriculture. They were planted May 16, 1905, on acre plat 19:

PLANTED MAY 16, 1905. ACRE PLAT 19.

Variety No.	*Fraction of acre*	*Yield, lbs.*	*Yield per acre, lbs.*
9950	0.125	53.5	428.0
9958	0.170	40.5	238.2
9947	0.172	65.0	377.9
9926	0.128	21.5	168.0
9937	0.088	39.0	443.2
9922	0.066	19.0	287.9
9943	0.048	8.5	173.0
9921	0.039	7.0	179.5

FRUIT EXPERIMENTS.

The Fourteenth General Assembly of Wyoming appropriated $2,000 for two years to be expended at Lander in fruit experiments. This money was to be placed at the disposal of a Horticultural Experimental Commission, to be appointed by the Governor. Governor Brooks appointed on this commission, Mr. Edward Young of Dallas, Fremont County; Mr. J. M. Hornecker of Lander, Fremont County; and myself. The commission met at Lander and organized the work, which was to be carried on at the Lander Experiment farm, where there was an apple orchard in a bearing condition. The last Legislature re-enacted a clause in the general appropriation bill appropriating another $2,000 for two years, ending April 1, 1909, and the Governor reappointed the old commission to continue the work. A large number of varieties of fruits were planted at Lander, the orchard fenced, and the land placed in good condition. It has not been possible to obtain

results of value in so short a time, especially because a hail storm destroyed the crop last year, on the bearing portion of the orchard. On January 1, 1907, as Secretary of the Commission, I made the following report to the Governor:

EXPERIMENTAL HORTICULTURAL COMMISSION.

Money appropriated for two years, $2,000. Expenditures to January 1, 1907, $1,505.88. This includes a bill of $33.88 not yet paid by the State Auditor. The general items are as follows:

Appropriation for two years		$2,000.00
Trees and plants	$ 296.78	
Freight and express	186.84	
Implements	62.91	
Labor	846.80	
Fencing	79.40	
Incidentals, including telegraph, telephone, repairs, etc.	33.15	
	$1,505.88	
Estimated expenditures up to April 1, 1907	497.12	
	$2,000.00	$2,000.00

The growing of fruit takes time, and the planting so well begun at Lander should not be allowed to deteriorate or die, on account of lack of support. The old orchard on the Experiment Station farm at Lander is in a bearing condition, and in connection with the new planting should give results of great value to the State. On account of a heavy hail storm on the 13th of July, no fruit was matured last season.

In order that the money expended shall give the adequate return to the State, I suggest that the Legislature should make suitable provision for the continuation of this work.

EDWARD YOUNG,
J. M. HORNECKER,
B. C. BUFFUM.
By B. C. BUFFUM,
For the Commission.

Report of the Botanist.

The work as planned for the year has been carried out in so far as the circumstances would permit. Since the lines of investigation were not finally adopted until the first of the fiscal year, beginning July 1, 1906, it was too late in the season to get some of the lines started before the spring of 1907.

The season, however, was not wasted, for much time (July and August) was spent in the field in the study of orchard and crop conditions and diseases. The data secured concerning the diseases then prevalent were of interest to the Experiment Station and the State Board of Horticulture jointly. Two publications have resulted from these investigations, as follows: (1) The First Biennial Report of the State Board of Horticulture, dealing exhaustively with the status of the fruit industry of the State, and (2) Experiment Station Bulletin No. 70, "Some Potato Diseases—Their Cause and Control." Among the technical subjects discussed in the horticultural report are fire blight and other fungous diseases of the orchard; orchard insects; spraying and spraying formulæ (Fungicides and Insecticides). A discussion of varieties of fruit suitable for Wyoming conditions rests upon data from the fruit growers of the State secured through interviews and a considerable correspondence, as well as upon observation in the orchards themselves. The potato diseases discussed in the bulletin cited are (1) Early Blight, (2) Late Blight, (3) Scab, (4) Rhizoctonia. The field work also occasioned the preparation of several popular articles on orchard and field diseases and insects. These were published in the *Ranchman's Reminder* and in some of the papers of the State.

In the considerable correspondence of the year this item at least ought to be mentioned, for the sake of the record.

So far as the writer knows, the Seventeen-year Locust (*Cicada septem-decem*) has not heretofore been reported from this State. In July of last year a brood appeared in at least two of the canons in the eastern foothills of the Big Horn Mountains in Sheridan County, viz., at Absaraka Park, and in Wolf Creek Canon. The fact did not come to our notice until after the brood had disappeared. As is usual, it was found that the young orchards had suffered greatly. The trunks and branches had been punctured till they looked like ragged bits of sieve. Of course, all such trees died in a short time after the injuries were inflicted.

The lines of investigation in which work is in progress are enumerated in the appended Plan of Work for 1907-08. Most of them are of such a character that several seasons will be required before any definite results can be expected.

An experimental orchard of about two hundred trees has been planted, consisting mostly of apples and crabs of several varieties. Besides these, a few plums, cherries, and pears were included. The main points to be tested are the hardiness and adaptability of the several varieties. On these high table-lands of this part of Wyoming the first question must necessarily be, "What will live?" and not, "What is the best in quality?" This orchard, or such portion of it as may be induced to live, will also serve as an immediately accessible place in which to study the orchard enemies at high altitudes. Other parts of the State with relatively low altitudes permit a wider range of study, but the distances allow only occasional observations.

In addition to the experimental orchard, a considerable variety of ornamental stock is being tested, including trees, shrubs, and herbaceous perennials.

PLAN OF WORK FOR 1907-08.

WORK UNDER WAY.

1. The development of Alkali-resistent forage.

2. Experiments with standard and small fruits to test their hardiness and adaptability.

3. Insect enemies and fungous diseases of the orchard.

4. Breeding of a desirable perennial aster, using *Xylorrhiza Parryi* as the parent stock.

5. Breeding of a hardy flowering shrub, using *Jamesia Americana* as the parent stock.

ADDITIONAL WORK PLANNED.

1. The effect of soils of different character upon potato scab, Early Blight and Rhizoctonia.

2. Diseases of shade trees.

Report of the Chemists.

HENRY G. KNIGHT AND FRANK E. HEPNER.

The work in this department has been carried on along the same lines as during the year of 1905-06. No new work has been taken up.

The problems which have occupied our attention may be discussed under the following heads:

I. Wyoming Forage Plants and Their Chemical Composition. (In co-operation with the Botanist.)
II. Digestion Experiments with Wethers. (In co-operation with the Animal Husbandman.)
III. Soil Moisture Determinations.
IV. Milk Investigations.
V. Miscellaneous Work.

I. WYOMING FORAGE PLANTS AND THEIR CHEMICAL COMPOSITION.

The work along this line has been continued for the past three years. During the past year about thirty plants have been investigated, but the results will not be ready for publication until some time during the coming year.

Forage plants cure well here upon the range, and stock seem to do remarkably well upon the natural cured forage during the winter months. The composition of the winter forage and its relation to the composition of the green forage has been a matter of conjecture. July 5, 1906, four samples of grass were collected upon the University campus, and again samples were collected from the same plots of ground, December 3, 1906. These samples should fairly represent range conditions, as the plots were in the natural state and had never received irrigation. The results of the analyses are given below:

WESTERN WHEAT GRASS.

Agropyron occidentale Scribn.

ANALYSES.

Summer Sample; in Bloom.

	Green	Air Dry	Water Free
Water	49.40	5.01	....
Ash	2.55	4.78	5.03
Ether Extract	1.55	2.92	3.07
Crude Fiber	18.57	34.86	36.70
Crude Protein	4.67	8.77	9.23
Nitrogen-free Extract	23.56	43.66	45.97

Winter Sample.

	Air Dry	Water Free
Water	5.76	....
Ash	5.27	5.59
Ether Extract	2.51	2.67
Crude Fiber	38.16	40.49
Crude Protein	2.94	3.12
Nitrogen-free Extract	45.36	48.13

INDIAN MILLET.

Eriocoma cuspidata Nutt

ANALYSES.

Summer Sample; in Bloom.

	Green	Air Dry	Water Free
Water	52.89	5.25	....
Ash	2.35	4.73	4.99
Ether Extract	1.08	2.08	2.20
Crude Fiber	14.12	28.40	29.97
Crude Protein	5.35	10.75	11.35
Nitrogen-free Extract	24.26	48.79	51.49

Winter Sample.

	Air Dry	Water Free
Water	5.98	....
Ash	6.35	6.75
Ether Extract	1.83	1.95
Crude Fiber	36.40	38.71
Crude Protein	3.92	4.17
Nitrogen-free Extract	45.52	48.42

NEEDLE GRASS.

Stipa comata.

ANALYSES.

Summer Sample; in Bloom.

	Green	Air Dry	Water Free
Water	52.49	4.55	....
Ash	2.21	4.43	4.64
Ether Extract	0.73	1.46	1.53
Crude Fiber	17.27	34.70	36.36
Crude Protein	4.10	8.24	8.63
Nitrogen-free Extract	23.20	46.62	48.84

Winter Sample.

	Air Dry	Water Free
Water	5.73	....
Ash	3.39	3.60
Ether Extract	1.21	1.28
Crude Fiber	39.61	42.02
Crude Protein	3.18	3.37
Nitrogen-free Extract	46.88	49.73

PRAIRIE JUNE GRASS.

Koeleria cristata.

ANALYSES.

Summer Sample; in Bloom.

	Green	Air Dry	Water Free
Water	50.25	5.75	....
Ash	2.59	4.91	5.21
Ether Extract	1.19	2.25	2.39
Crude Fiber	17.60	33.35	35.38
Crude Protein	3.08	5.83	6.19
Nitrogen-free Extract	25.29	47.91	50.83

Winter Sample

	Air Dry	Water Free
Water	5.88	....
Ash	6.24	6.63
Ether Extract	1.29	1.37
Crude Fiber	38.76	41.18
Crude Protein	2.49	2.65
Nitrogen-free Extract	45.34	48.17

In comparing the analyses of the summer samples with the winter samples, there will be noted many marked differences. There is a falling off in the percentage of protein in the winter samples in all four cases given above, which is quite remarkable. The amount of crude fiber is greater in the winter samples, as would be expected, while there is slight change in the proportion of nitrogen-free extract. The percentage of ether extract drops materially in the winter samples. If the digestibility of the range-cured grasses has not changed materially, it may be readily understood why stock thrive so well upon the open range in Wyoming during the winter months.

It is hoped that digestion experiments may be carried on to determine the digestibility of some of our winter range forage.

II. DIGESTION EXPERIMENTS WITH WETHERS.

Until the past year the digestion experiments carried on at this Station were conducted with two wethers. During the past year three wethers have been used, which we find make the results more satisfactory and probably more nearly correct. The results of the year's work have not as yet been published.

III. SOIL MOISTURE DETERMINATIONS.

The moisture content of soils collected by the Dry Farm Department was determined in this department. About fifteen hundred analyses were made during the past year.

IV. MILK INVESTIGATIONS.

In the state food law, passed by the Wyoming Legislature, 1903, the legal requirement of milk is given that it must contain 12 per cent total solids, one-fifth of which must be fat. In working under this law it was found that a large percentage of the milks collected over the State did not come up to the

legal requirement in total solids and fat, and in most of these cases it was not believed that the milk had been adulterated.

Several herds from dairies distributing milk in Laramie were used for the investigations. The milk was collected morning and evening as the cows were milked, and analyses made of samples taken from the milk of each cow. The results made it appear that the time of milking and the period between milkings is one of the prime causes of the change in the amount of solids in the milk, for in most cases, if the night and morning milk were mixed, the solids and fat would exceed the legal requirements.

The results of this investigation are being written up by Mr. Ross B. Moudy and will be published later.

V. MISCELLANEOUS WORK.

Under this head is included work done upon material sent in by those interested. Much of it will be of little or no value to the Station, except as occasion arises, when the notes can be used for reference. Occasionally this class of work draws materially upon the time of the Station staff and in that respect must be taken into account. In no instance, however, has it been allowed to interfere with the regular work outlined by this department.

Report of the Irrigation Engineer.

HERBERT T. NOWELL.

The work of this department was divided into the following lines of investigation:

1. Irrigation Practice.
   a. Duty of Water on Field Crops.
   b. Amount of Water Needed for Maximum Crop.
2. Drainage Investigations.
3. Soil Moisture Determinations.
   a. On Wind-Mill Irrigated Plats.
   b. On Dry Farm Plats.
   c. On Winter Irrigated Plats.

The time of the Irrigation Engineer was largely given to the taking of records and the superintending of the irrigation at the Laramie Experiment Station farm. Once each week, as regularly as possible on the same day of the week, a trip was made to Cheyenne, sometimes alone and sometimes with an assistant, for the purpose of taking samples of soil on the different plats on the Government Irrigation Extension farm at Cheyenne, Wyoming. A report of this work is given herewith. These trips occupied from one to three days each week throughout the season from June 26th to October 17th. Drainage investigations have been started on the old penitentiary farm, which was donated to the University by the Fifteenth State Legislature and is now known as the Wyoming Agricultural College Stock Farm. Surveys and plans were made for the drainage of this farm, so that all would be in readiness for this work should funds become available for the purpose. It seems to the Irrigation Engineer that this would be a valuable work, and if it is accomplished the hay crops for stock feeding can be grown on this farm, which will relieve the experimental farm to a large extent and open a much larger area there for

plat work, plant breeding, irrigation experiments, and other important experiments of great value to the State, for which there is scant room at the present time.

Duty of Water on Field Crops.—Careful records were taken of the amount of water used on each plat at the Experiment Station. The water was measured by being passed over Cippoletti wiers, being recorded both by an automatic water register and by a note-book record kept by the Irrigator. With this check it is thought that the measurements are of sufficient accuracy to be of great value in the annual determination of water duties at the Experiment Station farm.

Bulletin No. 72 was published during February, and gave the results of the tests of the duty of water on Canadian Field Pease. This bulletin throws light on the proper amount of water needed for this crop, and the possibilities it offers as a money maker under proper methods of irrigation.

Drainage Investigations.—Besides the survey and plans for the drainage of the stock farm, test wells were dug at various places along a line approximating the direction of travel of the seepage water through the farm. These wells were dug with a post hole auger to a depth of three to four feet, and were lined with porous drainage tile and left open. Measurements of the water level in these wells were taken throughout the season and plans laid for the extension of this work the coming season, so that information may be collected as to the action of the seepage water.

Moisture Investigations at the Government Irrigation Extension Farm at Cheyenne.—This work is to be continued the coming season, and it is the opinion of the Engineer it should be kept up co-operatively with the Office of Experiment Stations of the United States Department of Agriculture and the Chemistry Department at the University, until the action of soil moisture under different conditions of evaporation, soil culture, crop, and irrigation or rainfall, is determined and

corroborated by at least three years of this work, so that some definite information of both practical and scientific interest will be obtained along this important line.

SOIL MOISTURE AT THE CHEYENNE IRRIGATION EXTENSION FARM

Co-operative Work.—The Government Demonstration Farm in Cheyenne was started in the summer of 1905, the land being fallowed during that year, a part of it planted in winter wheat and rye in the fall of 1905, and the remainder planted in the spring of 1906. The management was in the hands of the Irrigation and Drainage Investigations, United States Department of Agriculture, and the work was aided financially by the railroads and individuals at Cheyenne. The Agricultural Experiment Station, at Laramie, appropriated $500 to aid in this work, and the Director of the Experiment Station offered any assistance he could give in the work. In the spring of 1906 it was decided that, instead of helping financially with the general farm work, it would be better for the Experiment Station to co-operate with the Irrigation Investigations, and the writer was engaged to undertake soil moisture experiments and tests under this arrangement. The Department of Chemistry, through the Experiment Station Chemist, agreed to assist in the work to the extent of making determinations of the moisture content of the soil, when the samples were delivered. So that the results herein given are due to co-operation between the Irrigation and Drainage Investigations, the Department of Irrigation Engineering, and the Department of Chemistry at the University of Wyoming.

Plan of Experiments.—The Government "Dry Farm" at Cheyenne, as it is generally, but incorrectly, known, consisted. in 1906, of three general series of experimental plats. The first was to be irrigated with reservoir water raised by windmill; the second series was to be dry farmed pure and simple; the third series, on what is known as the south side farm, was to be winter irrigated, one section of it having a thorough soak-

ing once during the winter, the other part receiving two thorough irrigations during the non-growing season. The division by series of the whole farm was as follows:

Series A—Wind-mill irrigation.
Series B—Dry farmed every year.
Series C—Dry farmed and summer fallowed alternate years.
Series D—One winter irrigation.
Series E—Two winter irrigations.

Plan of Irrigation and Dry Farming Experiments at Cheyenne Experiment Farm, Season 1906.

Not subsoiled Sample No.			Plat		Size of plat, acres	Crop planted	Rate of planting per acre, lbs.	Distance drill rows, inches	Depth plowed, inches	Cultivated	Date seeded	Subsoiled Sample No.		
First ft.	Second ft.	Third ft.	Series	Number								First ft.	Second ft.	Third ft.
1	2	3	A	1	½	Field Pease	90	8	½ 8, ½ 8 & subsoiled	No	April 14	88	89	90
4	5	6	A	2	½	Defiance Wheat	44	8	" " "	No	" 11	91	92	93
7	8	9	A	3	½	" "	44	16	" " "	Deep	" 11	94	95	96
10	11	12	A	4	½	" "	44	16	" " "	Shallow	" 11	97	98	99
82	83	84	A	5	½	Alfalfa, nurse crop	20	8	" " "	Discing	May 17	100	101	102
13	14	15	A	6	½	" " "	20	8	" " "	No	" 17	103	104	105
16	17	18	A	7	½	Potatoes	500	42	" " "	Ridges	" 16	106	107	108
85	86	87	A	8	½	"	500	42	" " "	Surface	" 16	109	110	111
19	20	21	A	9	½	Fall Rye	56	8	" " "	No	Sept. 15	112	113	114
22	23	24	A	10	½	Spring Rye	60	8	" " "	No	April 11	115	116	117
145	146	147	B	1	1	Field Pease	90	½ 8, ½ 16	½ 8, ½ 8 & subsoiled	No	April 14	25	26	27
148	149	150	B	2	1	Spring Durum	44	8	" " "	No	" 13	28	29	30
...	...	...	B	3	1	" "	44	16	6	Deep	" 13	118	119	120
...	...	...	B	4	1	" "	40	16	6	Shallow	" 14	31	32	33
151	152	153	B	5	1	Alfalfa, nurse crop	20	8	6	Discing	May 17	34	35	36
154	155	156	B	6	1	" " "	20	8	6	No	" 17	121	122	123
157	158	159	B	7	1	Potatoes	500	42	6	Ridges	" 18	124	125	126
160	161	162	B	8	1	"	500	42	6	Surface	" 18	37	38	39
163	164	165	B	9	1	Fall Rye	56	8	6	No	Sept. 15	40	41	42
166	167	168	B	10	1	Spring Rye	56	8	6	No	April 13	43	44	45
190	191	192	C	1	½	Spring Durum	44	16	8	Spring tooth	April 14	46	47	48
196	197	198	C	2	½	" "	44	16	8	Gopher blade	" 14	127	128	129
199	200	201	C	3	½	" "	44	16	8	Peg tooth	" 14	130	131	132
202	203	204	C	4	½	" "	44	16	8	Sweep attachment	" 14	139	140	141
169	170	171	C	5	½	Alfalfa, nurse crop	20	8	8	No	May 17	133	134	135
172	173	174	C	6	½	" " "	20	16	8	Yes	" 17	49	50	51
175	176	177	C	7	½	Potatoes	500	54	8	Ridges	" 18	52	53	54
178	179	180	C	8	½	"	500	54	8	Surface	" 18	136	137	138
184	185	186	C	9	½	Fall Rye	56	16	8	Yes	Sept. 15	142	143	144
187	188	189	C	10	½	Spring Rye	60	16	8	Yes	April 13	55	56	57

Plan of Irrigation and Dry Farming Experiments—Continued.

Sample No.			Plot		Size of plot, acres	Crop planted	Rate of planting per acre, lbs.	Distance drill rows, inches	Depth plowed, inches	Cultivated	Date seeded
First ft.	Second ft.	Third ft.	Series	Number							
61	62	63	D	1	½	Defiance Wheat	44	8	¼ 4. ¼ 6. ¼ 8. ¼ 8 and subsoiled	No	April 20
64	65	66	D	2	½	Silver King Wheat	44	8	“ “ “ “ “	No	. . . .
67	68	69	D	3	½	Defiance Wheat	44	16	“ “ “ “ “	Yes	“ 20
70	71	72	D	4	½	Winter Rye	56	8	“ “ “ “ “	No	. . . .
79	80	81	D	5	½	Spring rye	56	8	“ “ “ “ “	No	“ 14
. . .	. . .	. . .	D	6	½	Alfalfa, nurse crop	16	8	“ “ “ “ “	No	May 17
73	74	75	D	7	½	Alfalfa, Turkestan	16	8	“ “ “ “ “	Discing	. . . .
76	77	78	D	8	½	Potatoes	500	86	“ “ “ “ “	Ridges	“ 19
205	206	207	D	9	½	“	500	36	“ “ “ “ “	Surface	“ 19
208	to	219	D	10	½	Field Pease	90	8	“ “ “ “ “	No	April 20
. . .	. . .	. . .	E	1	½	Defiance Wheat	44	8	¼ 4. ¼ 6. ¼ 8. ¼ 8 and subsoiled	No	April 20
. . .	. . .	. . .	E	2	½	“ “	44	16	“ “ “ “ “	No	“ 20
. . .	. . .	. . .	E	3	½	“ “	44	16	“ “ “ “ “	Deep	“ 20
229	230	231	E	4	½	“ “	44	16	“ “ “ “ “	Shallow	“ 20
. . .	. . .	. . .	E	5	½	Potatoes	500	30	“ “ “ “ “	Ridges	May 19
226	227	228	E	6	½	“	500	30	“ “ “ “ “	Shallow	“ 19
. . .	. . .	. . .	E	7	½	Field Pease	85	8	“ “ “ “ “	No	April 20
223	224	225	E	8	½	“ “	85	16	“ “ “ “ “	Yes	“ 20
. . .	. . .	. . .	E	9	½	Alfalfa, Turkestan	19	8	“ “ “ “ “	Discing	“ 20
220	221	222	E	10	½	“ “	19	8	“ “ “ “ “	No	“ 20

Moisture Work.—After a preliminary test early in June, 1906, the main series of moisture determinations was begun on June 26th, and continued to October 17, 1906, moisture samples being taken on Tuesday of each week, excepting two or three instances where train connections or the weather prevented. In this case they were taken on Wednesday. The plan was to have a complete set, from these 24 plats, taken within one day each time, and at equal intervals throughout the season, so that conditions would be comparable in every way possible.

Method of Taking Samples.—At first the instrument used in taking the samples was a post-hole digger, three inches in diameter, but as the soil grew dryer it was found that this was too slow and imperfect, so that a special auger four feet long, the bit at the end being similar to a wood-boring bit, but without the tip, was used. Three samples were taken in each plat; the first from a depth of about 2 inches to 12 inches; the second from 12 to 24 inches; and the third from 24 to 36 inches. Each sample was, as near as it could be made, an average of the total amount of soil raised from the given depth. In many instances after the soil became so dry that it was hard to raise by the auger, the sample consisted of the total amount raised from the given depth. As the samples were obtained they were put into the receptacle used, closed up, and put within the carrying case to prevent escape of moisture. At first glass bottles, cylindrical in shape, and with tin screw caps fastened tightly against the cork top, were used, but these bottles were found too delicate for the service, several samples being lost through the breakage of bottles. Next tin cans, holding about 100 grams of soil sample, were employed. The top of these tin cans slid snugly into place against a raised rib. For a while rubber bands were used around the cans to seal them air tight, but it was found that these were unnecessary, as the loss of moisture through the opening in the tin covers was negligible. As the soil became

very dry and crumbly toward the end of the growing season, the auger would not raise sufficient quantities for the samples needed. In cases of this kind a soil tube was used, consisting of a four-foot gas pipe of about 1½ inches diameter, the edges sharpened at the lower end and tempered. This was driven into the hole bored by the auger, by the use of a wooden mallet, and compacted the soil within the lower end of the tube so that it could be raised. In some instances the fine, sandy formation, which was struck at about 30 inches deep, usually, became so dried out and cemented with gravel that it was impractical to penetrate it below this depth, so that the third sample, when containing less than 7 or 8 per cent of moisture, was usually obtained between the depths of 24 and 30 inches, instead of 24 to 36 inches. In many cases several holes were bored to a depth of about 30 inches and were stopped because it was impossible to bore them to the deeper limit. Every week the writer traveled back and forth between Laramie and Cheyenne, the large expense of railroad fare being overcome to some extent by the use of a pass kindly furnished by the Union Pacific railroad for this work. As the soil became very compact through drying out, it became necessary to have an assistant, in order to get all of the 72 samples in a day. Once a month a larger number of samples were taken on plats that were not generally sampled. These monthly samples ranged in number from 206 to 231, and were usually taken in three days for the set. The samples were brought to the University of Wyoming in cases and delivered to the Department Chemist, where Mr. Hepner, assisted at times by Mr. Smith, made determinations of the percentage of moisture obtained in the soil.

The Work of the Chemist.—These determinations were made by weighing the sample and covered container on a delicate torsion balance, removing the cover, drying in an air oven at about 105° C. for 18 to 20 hours, recovering, cooling, and weighing again. By having the container and cover tared, the weight and percentage of moisture was easily calculated.

These per cents are calculated on the dry soil. This supposes that the soil was perfectly dry when weighed, after drying for the above stated length of time. After trial, it was decided that the error so made was too small to be considered. The tables of soil moisture per cents were made by Mr. F. E. Hepner, Assistant Chemist. The averaging and charting were done in the Irrigation Department.

Objects of Experiments.—In planning the system of soil moisture determinations several objects were kept in view, the principal ones being the following: To ascertain the minimum amount of soil moisture which would keep the plant alive, and also the minimum amount at which the plant would continue to grow, it being thought that many drouth-resistant plants will not wilt for a short period even though there is less moisture in the soil than would enable them to thrive and grow. This might be called the rest period of the plant. It was also expected to determine the average amount of moisture in the soil during the different periods of the plant growth. The relative drouth resistance of different plants experimented with was one of the most important things to determine, also the relative value of different soil cultures in conserving the moisture in the soil. By obtaining the yields on the different plats it was hoped also to get at least tentative data on the effect of the percentage of soil moisture on the producing capacity of the plant. Besides these main objects it was planned so to diagram the results of moisture determinations that various important deductions might be made therefrom. It was understood that whatever results were obtained the first year would be only tentative, and need confirmation by later determinations carried on under the same system.

Working Up the Data.—Under the paragraph of "The Work of the Chemist," the method of making the percentage determinations was given. The form of note-book used for this purpose is shown by the heading given below:

SAMPLE NUMBER.

Date	Dish and soil	Dish and Dry soil	Dish	Dry soil	Water	Per cent Water	Remarks

The data was obtained from the Chemist in the above form. Averages were made both for the crops of the same kind under all cultures, cultures of the same kind for different crops, and the three samples for the same plat are averaged to get the general average of the soil moisture in each plat. It was found that tabulating the results did not give so much information, nor could it be so readily obtained as by the method of charts. Therefore, the charts introduced into this report were made. First the data obtained from the tables was plotted on ordinary cross-section paper, to find which charts gave the most information and were, therefore, the most valuable for reproduction by printing. The special form of chart was then drawn, rainfall and evaporation curve introduced, and a zinc etching made on a reduced scale and chart forms printed. On this special cross-section sheet the data best suited to the purpose of illustration was then drawn, and in many cases the deductions given in results were made directly from the chart instead of from the tables, only a slight error being introduced thereby, for which the convenience of this method more than compensated. It will be noticed in the charts that an occasional determination seems unexplainable by the rainfall and evaporation curve, or by the determination of similar plats made at the same time. In cases such as this it seems probable that the error was made either in the weight of the cans or in the gathering and transportation of the samples.

In making the charts, where two lines were practically superimposed it was found necessary to place them a short distance apart, for clearness in reading, so that a trifle more variability shows in the charts where lines are close together than is shown by the tables.

Probable Accuracy of the Determinations.—It was found by duplicate determinations upon the same plat that commonly the soil moisture within a plat did not vary more than 3 per cent, but in a few instances it was apparent that the test hole must have struck what may be called a "pocket" of soil moisture. There is evidence, from the composition of the soil in these cases, that it must have been an old hole of some kind, probably made by gophers, the soil being more thoroughly mixed than in the usual run of samples. In the cases where this occurred we marked the tables with a star. There are also a few cases where the Chemistry Department expressed uncertainty as to the result. These are marked by double stars in the tables. Outside of these errors it is thought from experiments that the total error is not more, in any case, than 3½ per cent, and in only one trial case did it reach 1.9 per cent. As the work progressed and the soil became drier, more uniform in moisture content, we may quite safely assume, I believe, an accuracy of 1 per cent in the general run of the soil samples. While glass bottles were being used several were broken and the samples thus lost, or exposed to evaporation. In these instances the chart was constructed, using the value for the missing sample equal approximately to the average of those determinations on each side of it, and using also the curve of other similar plats as a check on the missing value. In the chart it will be noted that some remarkable variations in the curves do not seem directly tracable to the rainfall and evaporation curve, or to the culture or condition of the crop. Cases like this which seem to have no explanation are doubtless due to some local condition, such as unusual physical composition of that part of the plat, to an old gopher hole, or to a large piece of gravel in the sample. In order to obviate local conditions causing such variations, the holes were bored in the plats in a comparatively small space—that is, samples were taken within say 5 or 10 feet of each other, within any plat.

INDICATIONS AS TO THE BEHAVIOR OF SOIL MOISTURE.

It is a well understood fact that there can be no plant growth without moisture. Some plants have the remarkable power of living entirely upon moisture and gaseous nutriment extracted from the air, but the great body of plants derive their food from soluble nutrients dissolved in soil moisture and carried up by the roots. For any accurate knowledge of the needs of plants it is necessary to understand something of the method by which they feed, and the action of this desolvent moisture which is a prime necessity of growth. It is quite possible that there is a definite relation of the amount of water evaporated from the leaves of a plant during the whole period of its growth and the weight of the plant at the end of the period, for the reason that if the plant takes its nourishment through a soil solution of definite chemical composition, all of the mineral elements are left in the plant when the water evaporates or are given off from the plant as gases. If it should be found that some such definite relation exists between water used by the plant, and the amount of plant growth for a certain set of conditions, it will place even more importance on the water needed by crops than is now generally attributed to it. Because of the simplified conditions and the comparative uniformity of conditions of soil moisture, the study of this on dry farmed lands is of more exact scientific value than on irrigated land, or land which has such heavy rainfall that the water gathers into runlets and the moisture is thus concentrated in the lower places.

In general the moisture content of unirrigated land is all derived in the form of rain or snow. Under the conditions at Cheyenne, there is very rarely a rainfall so great that it cannot be absorbed directly into the cultivated ground, before it can gather on the surface and be concentrated into the lower areas by running over the surface. A record of the rainfall and other precipitation was kept at Cheyenne on the demonstration farm, and the precipitation part of the rainfall

and evaporation curve is taken from these records, though they varied somewhat from the official Weather Bureau records at Cheyenne, some two miles away. Unfortunately the evaporation records were rendered valueless throughout the season of 1906 by the fact that the evaporation tank had a small leak, through which water from the outside entered, so that the evaporation part of this curve is only an estimate from general knowledge of evaporation, and should not be taken as being accurate. It serves, however, to show what would have been the theoretical height of the water level in a soil tank exposed to the precipitation and evaporation throughout the season, and is useful for comparison with the charted curves of soil moisture on the several plats.

The moisture gained from precipitation is lost in two ways other than by the use of the plant in transpiration. It is lost by seepage below the depth from which the plants draw their supply, and by evaporation from the surface of the ground. As the precipitation on dry-farmed areas is usually very small, the loss by seepage below the sphere of usefulness of the plant is so insignificant that it may be neglected in this work. So that we might say that all of the moisture that falls on the ground is either lost by evaporation from the surface or used by the plant in transpiration from its leaves. It is to cut down the former of these, leaving more moisture for the latter, that methods of soil culture peculiar to dry farming are used. It is claimed by dry farmers that a surface mulch of soil kept in a fine state of cultivation breaks up the capillary action, and while this top mulch may become dry, it protects the moisture below from evaporation. Professor Fortier, in an address at the Fourteenth National Irrigation Congress, says: "Summing up this question of evaporation loss in irrigation, it is safe to assert that about one-half of the water which is applied to the fields escapes into the atmosphere from the surface of the soil without in any way benefiting the plant." He also states: "The tests * * * show that a 10-inch layer of dry

granular soil gives complete protection, that an 8-inch layer of the soil saves five-sixths of the moisture beneath, and a 4-inch layer two-thirds of the moisture." There is one other item which should not be neglected. This is what is called hygroscopic moisture, which is moisture held so closely to the par-

CHEYENNE IRRIGATION EXTENSION FARM.
Durum Wheat, on land plowed eight inches deep and subsoiled. Photo July 27, 1906.

ticles of soil that the plant is unable, as is generally supposed, though not conclusively proved, to absorb this moisture or make use of it. Hygroscopic moisture is considered quantitatively as the amount of moisture which a dry soil will absorb from the air, or that which will remain in it after being exposed thoroughly to evaporation in the air. In our deter-

minations no provision was made for separating hygroscopic moisture from other forms of soil moisture, such as capillary water or free water—that is, water subject to the influence of gravity. Our reason for not differentiating hygroscopic moisture was our opinion that it would complicate the results so as to make them of less value than the determination of the total amounts, and that the assumption that the plant cannot make use of this moisture has not been proved and may be misleading.

DISCUSSION OF THE CHARTS.

It will be noted on the ten charts that a rainfall and evaporation curve is drawn without relation to the percentage of soil moisture, but on the vertical scale of 1 inch equal to 9/10 of an inch precipitation, the horizontal scale being the time element of the cross-section paper. As explained, the lines going up and slightly to the right show precipitation and the lines slanting downward to the right show an estimated evaporation. The curve is arbitrarily begun at the 25 mark of the soil moisture scale. The data from the tables is entered at the crossing of the lines representing the depth at which the samples were taken and the percentage of soil moisture in the samples. These dots are then joined by a curved line which graphically illustrates the history of the moisture in the soil, June 26 to October 17, 1906.

Plate 1. This chart shows the effect of wind-mill irrigation on Defiance Wheat. It will be noted first: That during the irrigation period, the irrigation being light and uneven, there is practically no information of value that can be gathered from the charts. This was due to the unevenness of the irrigation, by which one sample might be taken in a fairly damp place, and another a few feet away might be taken almost dry. After the irrigation the plats lost moisture very rapidly, losing from 6 to 10 per cent in two weeks. It is probable, as shown by this chart, and learned by experience

with other experiments, that a small irrigation is very little help in adding soil moisture to the ground, and may even be a positive injury by causing the crust to bake and capillary action to be set up in the surface soil, which continues until more moisture is lost, by evaporation, than is gained by the irrigation. It is probable that this injurious effect of the small irrigation might be prevented by two methods: The first is by sub-irrigation, and the second by cultivation of the soil as soon as it becomes dry enough to work. Looking at the same chart, we find that the moisture in Plat No. A2 was retained within the soil much better than that of the other two plats. A2 had rows 8 inches apart, while the others were 16 inches apart. The amount of seed per acre sown on the three plats was the same, but on this plat (A2) the grain was thinner within the row and the ground better shaded. It is interesting to note, in this connection, that the yield from this plat was fully one-third greater than from either of the other two, being 927 pounds per acre, and the others being 677 and 700 pounds, respectively. There is no difference between the plats receiving deep and shallow cultivation, by inter-tillage, except between August 3d and 26th the one receiving deepest cultivation remained dryest, reaching on August 21st a minimum of 2.6 per cent in moisture. The lowest percentage reached by the shallow inter-tilled plat was 5 per cent. This shows that no advantage was gained by the inter-tillage of two of these plats, but it is quite possible that had only one-half as much seed been sown in the plat with the 16-inch rows as in that of the 8-inch rows, that is the same number of seed to the row, the yield might have been increased and evaporation diminished from these inter-tilled plats.

Plate 2. This chart contrasts two plats of field pease, one of which received no irrigation and the other a small irrigation, July 17th. The tremendous loss by evaporation immediately after a small irrigation is very evident here. In two weeks the percentage of moisture on Plat A1 fell about 14 per cent;

that on the plat receiving no irrigation fell only about 4 per cent in the same period of two weeks. While the first part of the season Plat A1 contained more moisture, soon after the irrigation it received, it fell behind in this respect, and did not afterward become as high in soil moisture as the non-irrigated plat.

Plate 3. This chart gives a comparison of fall rye under the methods of dry farming under rainfall alone, and with rainfall aided by a copious winter irrigation, the methods of cultivation being practically the same. During the larger part of the growing season it will be noticed that the dry farm plat contained a larger amount of water than either of the others. B9 was sub-soiled, it is true, but during this first year subsoiling had no noticeable effect. In regard to the yield, A9 was by far the lowest, with 272 pounds, B9 giving the largest yield, 491 pounds. In most places B9 and D4 contained almost the same amount of soil moisture, within the limits of error. The chart shows some advantages to lie with the winter irrigated plat, although the yield was 100 pounds less, it is true, which was probably due rather to the condition of the grain than any lack of moisture.

Plate 4. This chart is a comparison of the varieties of wheat sown on the Demonstration Farm, the Defiance and Durum Wheats as examples of the spring varieties and the Silver King as a sample of winter wheat. D2 showed a very high starting point June 26, the ground being quite wet at the time sample was taken. This plat, as well as D1 and D3, was winter irrigated. D2 lost moisture very rapidly, losing some 16 per cent in two weeks. It is probable that the first sample obtained was not a fair average of the plat, and that the average loss was much less than this. Until late in the season this plat did not regain the moisture lost, and continued with less moisture than any of the others. This may account for the less yield from the Silver King than from

any of the other varieties. The late summer irrigated and winter irrigated plats of Defiance Wheat retained about the same amount of soil moisture, and the yields were a little in favor of the wind-mill irrigated plats. Durum Wheat, dry farmed, showed an advantage over the others in retaining soil moisture, the yield being about the same.

Plate 5. This chart is a comparison of the effects of slight summer irrigation with that of a thorough winter irrigation, one of the winter irrigated plats without cultivation and the other with cultivation. The cultivated winter irrigated plat kept practically even with the three wind-mill irrigated plats in regard to retention of soil moisture, but the uncultivated winter irrigated plat kept below the others in this respect throughout most of the season.

Plate 6. This chart is a comparison of the methods of cultivation on alfalfa with an oat nurse crop. The uncultivated, not sub-soiled, plat was driest throughout the season. The sub-soiled and disced plat retained more moisture in the critical period between July 22d and September 9th than the sub-soiled plat cultivated with a tooth harrow. The advantage of surface cultivation is apparent in this chart.

Plate 7. This is a comparison of the advantages of different widths of rows, and sub-soiling, in the growth of unirrigated potatoes. The percentage of moisture in all three ran very high. Naturally the moisture in the plat with the 54-inch rows remained higher during most of the season than that of the others, it being a general rule that the thinner the plants are grown the less moisture will be lost by evaporation from the plant. Another remarkable feature shown by this chart is the greater effect of the rain on damp, loose ground than on dry, uncultivated ground, in raising the percentage of soil moisture. A rain of about ¾ inch July 14th increased the percentage of soil moisture on the well cultivated plats from nearly 4 to about 9 per cent. One of the explanations of this

greater effect is that the water is more quickly soaked into cultivated ground, especially when it is already damp, than is the case on uncultivated ground comparatively dry. The water on the dry ground is kept nearer the surface and more quickly evaporated than on the damp.

Plate 8. This chart is a comparison of plats of spring rye, rows differently spaced and cultivated. The most evident feature is the rapid loss of soil moisture in the early part of the season, during which the principal growth of the crop takes place. After the growth was over there was a gradual regain of moisture, and this may be noticed in almost all crops. There was perhaps a greater loss in the cultivated 16-inch rows, as was noticed in Plate 1, but even then this plat retained the largest amount of water for a considerable period between August 18th and September 21st.

Plate 9. This is a comparison of methods of cultivation of spring Durum Wheat. As the plan of cultivation was not carried out in practice, this chart would be misleading if a conclusion were drawn from it that no cultivation conserved moisture best. The comparison of yields with the chart evidence of soil moisture is, however, of value. B2, with the best amount of soil moisture throughout the growing period, gave the best yield, 1,645 pounds per acre. B4 and C1 alternated in preponderance of soil moisture, the average being about the same. The yield was also nearly the same, B4 being 1,331 pounds per acre and C1, 1,396 pounds per acre.

Plate 10. This chart is one of the most interesting of the series. The average percentage of soil moisture on all of the plats of one kind of crop was plotted and the resulting curves compared. As would be expected, the fallow land stood much the highest throughout the season, in percentage of soil moisture, the potatoes being almost intermediate throughout a large period of the season between the moisture in the fallow land and the general average of moisture in the other plats. The

yield from the potatoes correspondingly showed greatest results, even though it was cut down by disease. The Defiance Wheat was next best as a drouth resistant, or rather as a non-moisture-consuming crop. The next best crop from this standpoint, in the early part of the season, at least, was field pease. Alfalfa, with thick oat nurse crop, spring rye, and fall rye, consumed most moisture, in general, of all of the crops experimented with, the last being perhaps foremost in this regard.

Plate I

Windmill Irrigation

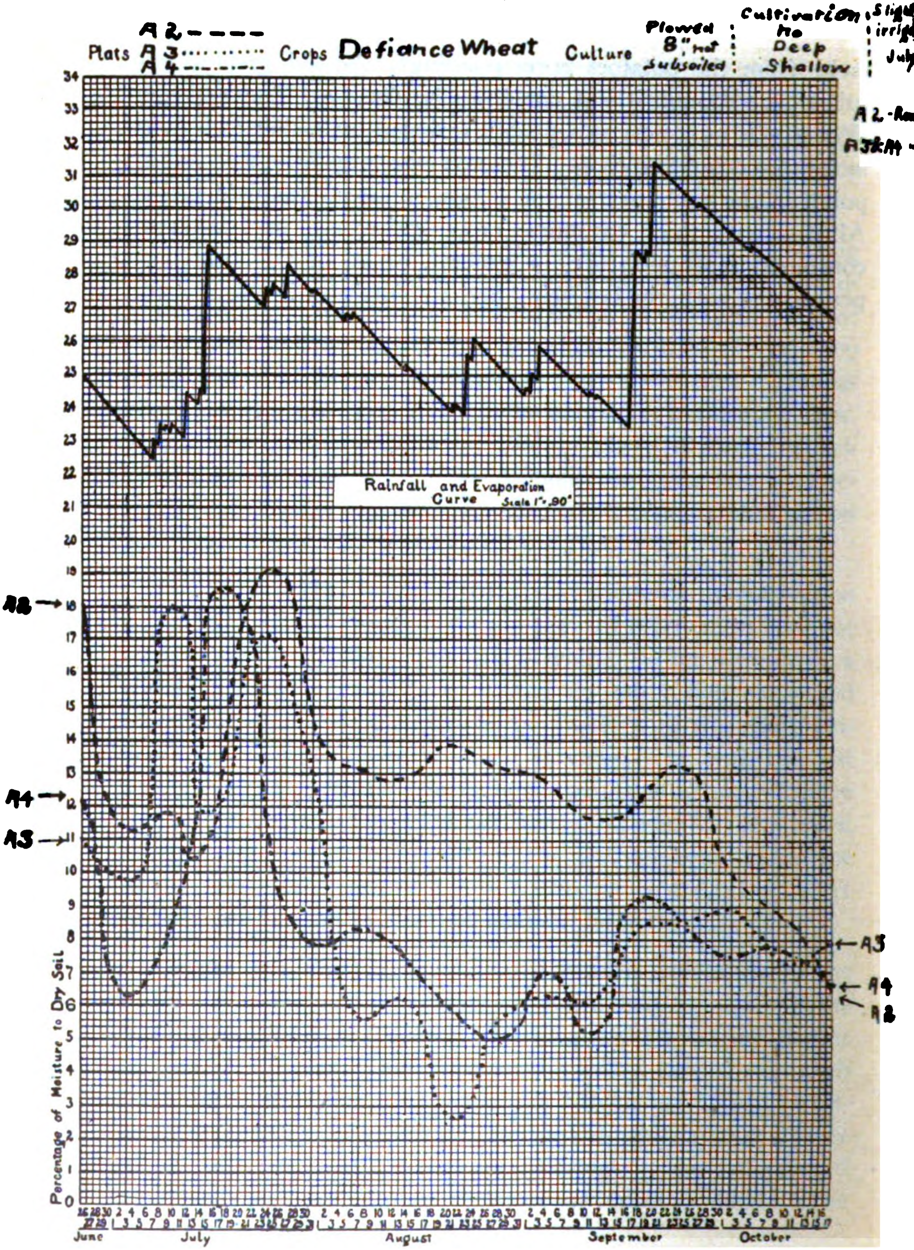
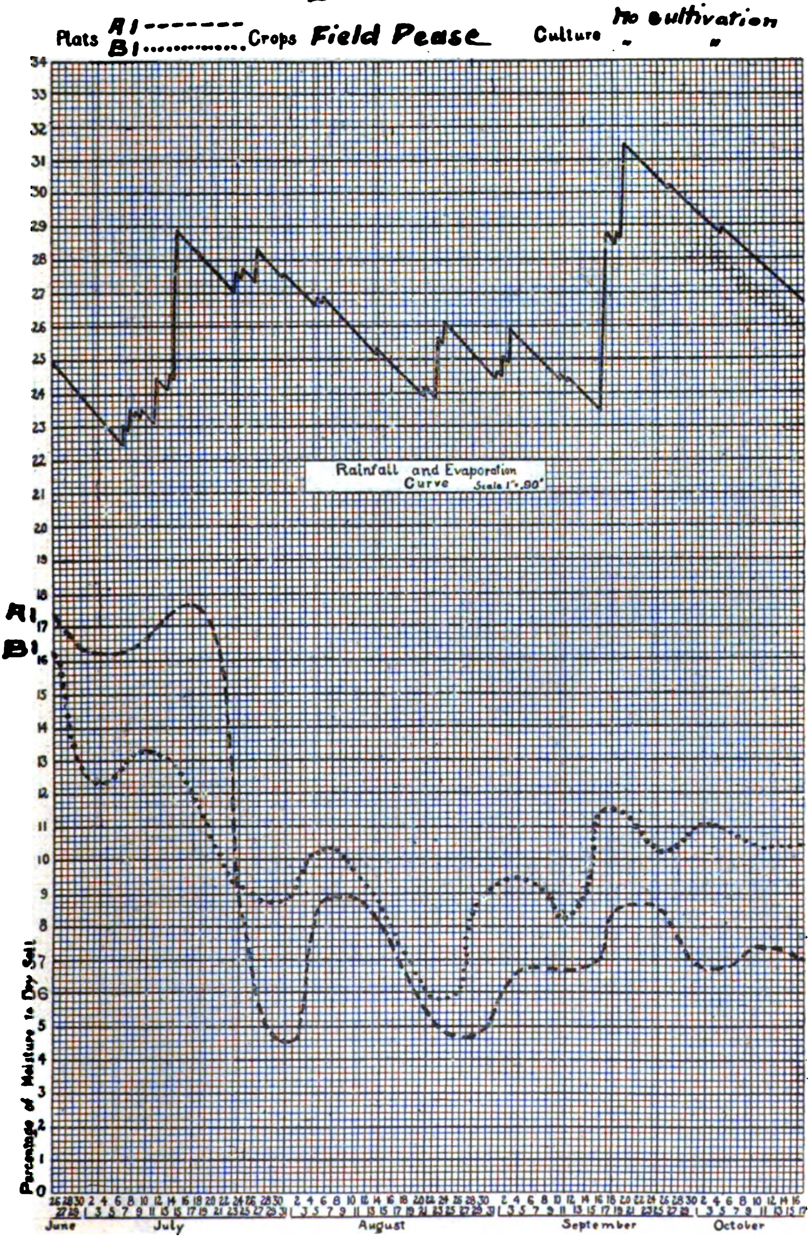


Plate 2 A1, Irrigation on July 10.
B1. No Irrigation.



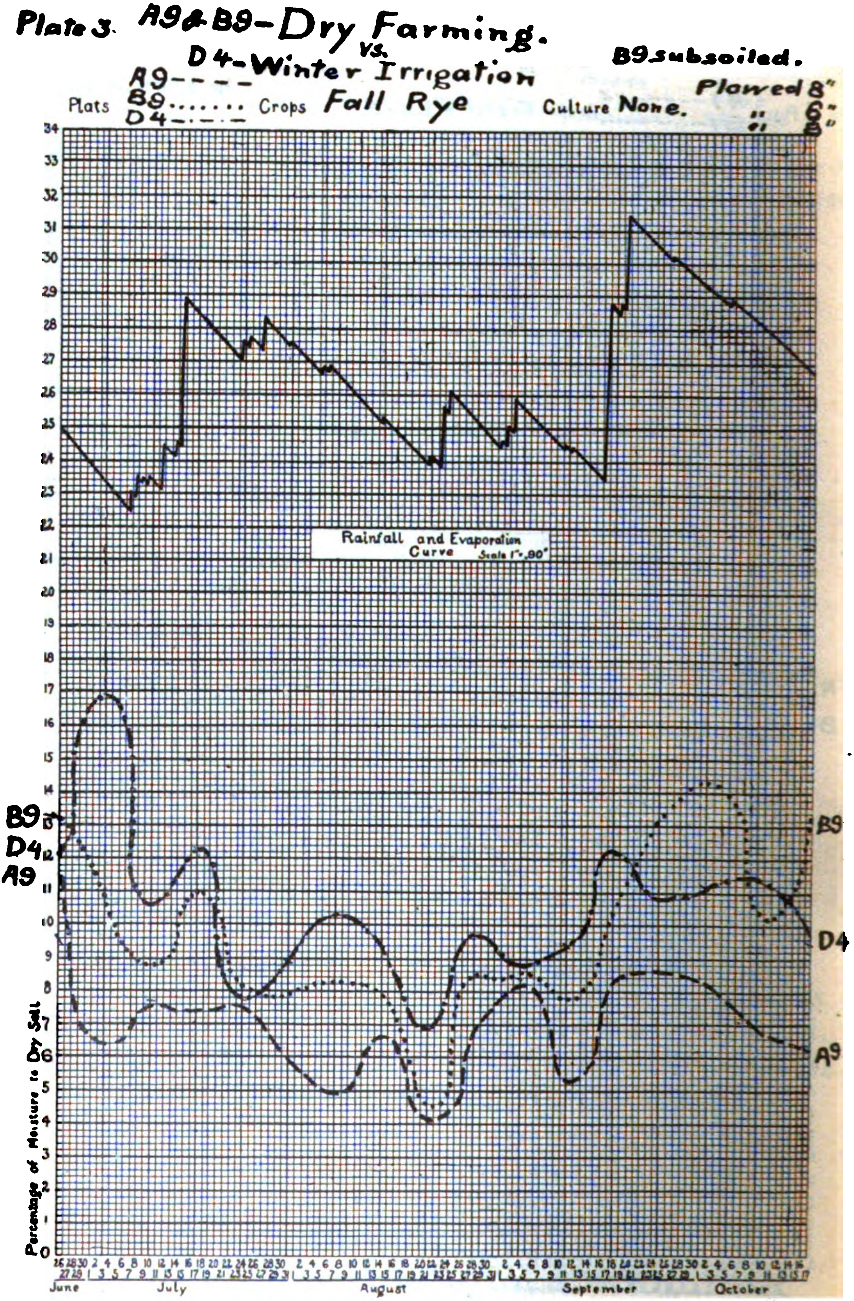


Plate 3. A9 & B9 - Dry Farming.
vs.
D4 - Winter Irrigation
B9 subsoiled.
Plats A9 - - -
B9 . . . . . .
D4 -.-.-
Crops Fall Rye
Culture None.
Plowed 8"
" 6"
" 8"
Rainfall and Evaporation Curve
Scale 1" = .80"
Percentage of Moisture to Dry Soil
B9
D4
A9
June
July
August
September
October

Plate 4 Wheat Crops.

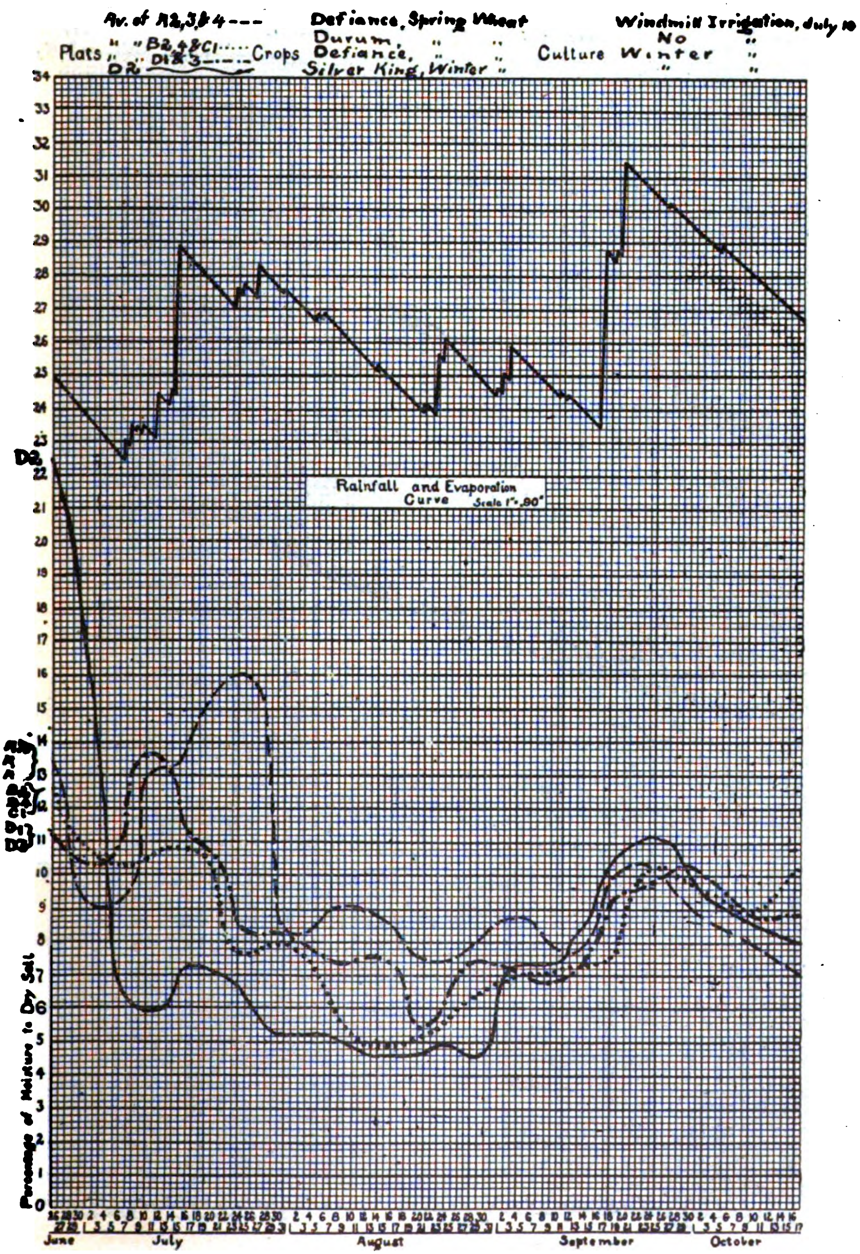


Plate 5

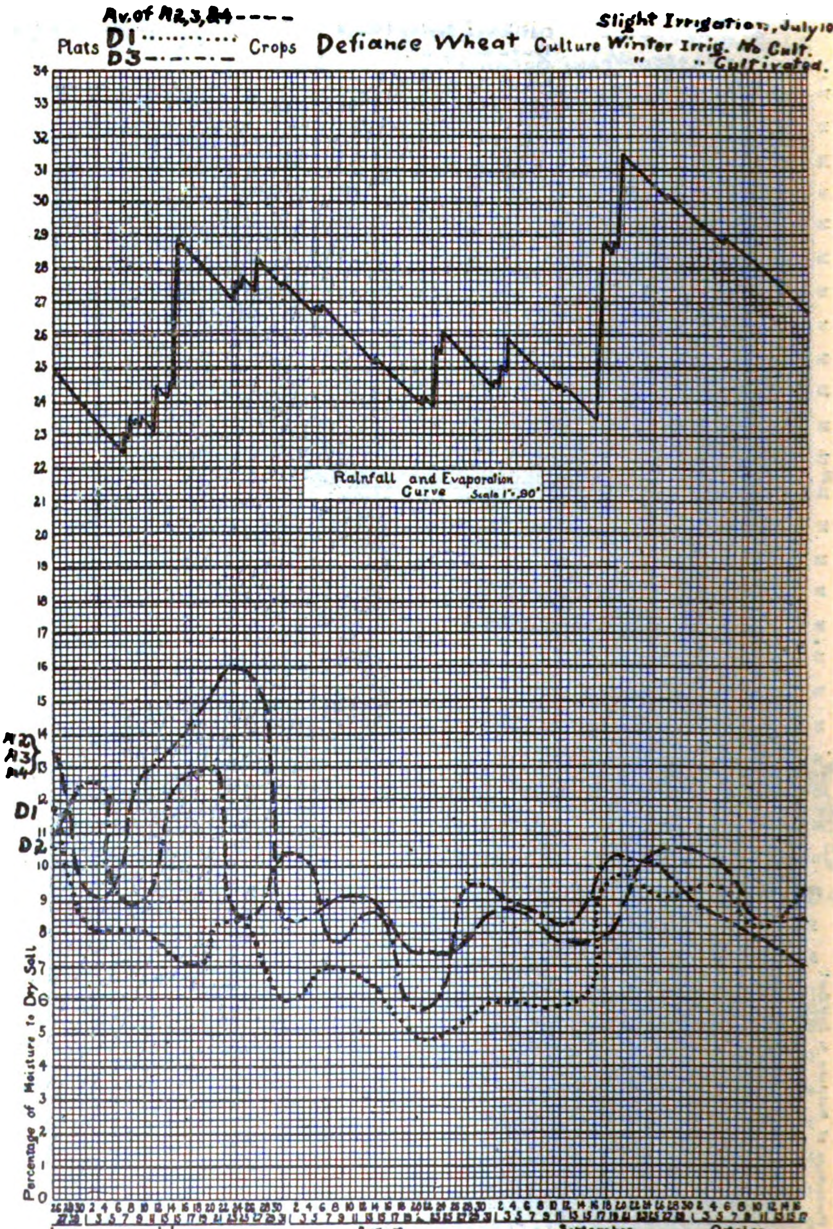

Av. of A2,3,&4 ----
Plats D1 ....
D3 -.-.-.-
Crops Defiance Wheat
Culture
Slight Irrigation, July 10,
Winter Irrig. No Cult.
" " Cultivated.
Rainfall and Evaporation Curve Scale 1"=.90"
Percentage of Moisture to Dry Soil
A2
A3
A4
D1
D2
June
July
August
September
October

Plate 6 Dry Farming

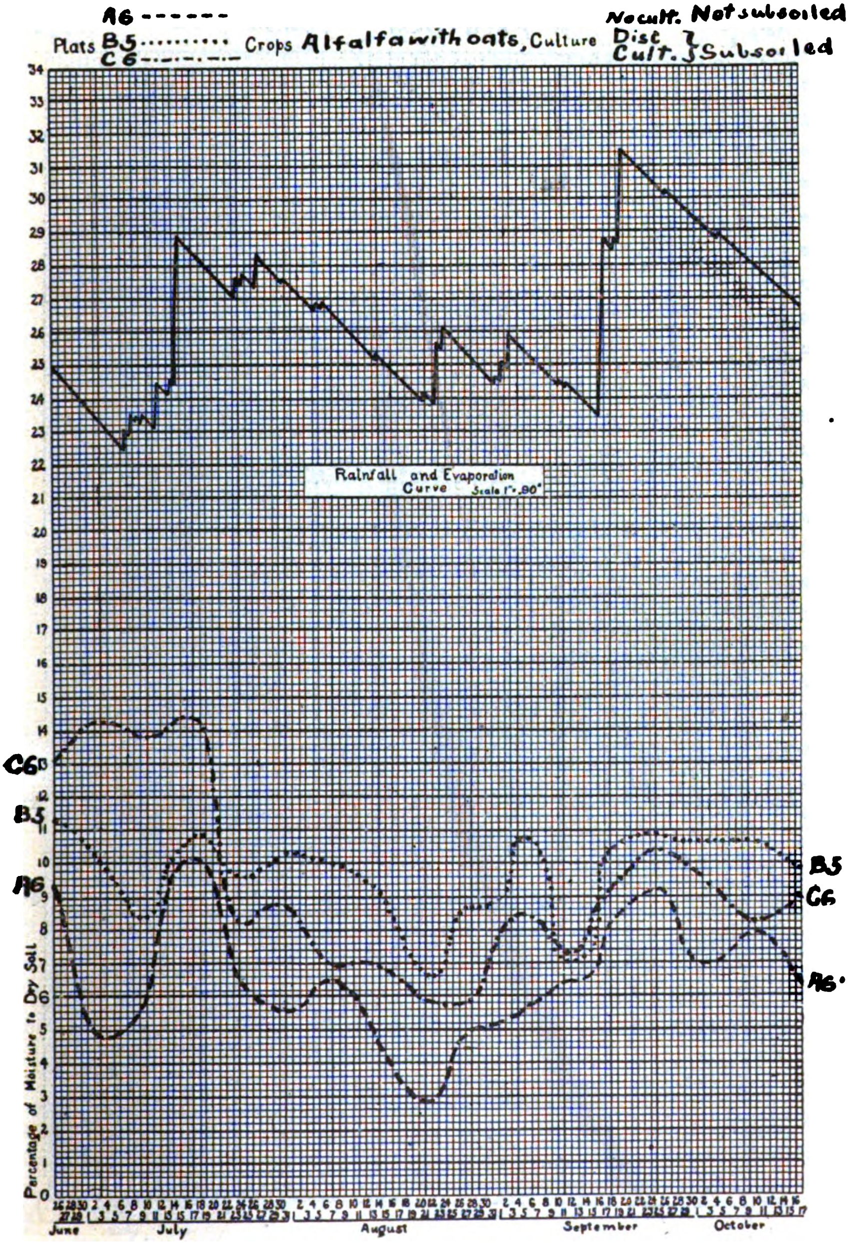


Plate 7

Dry Farming

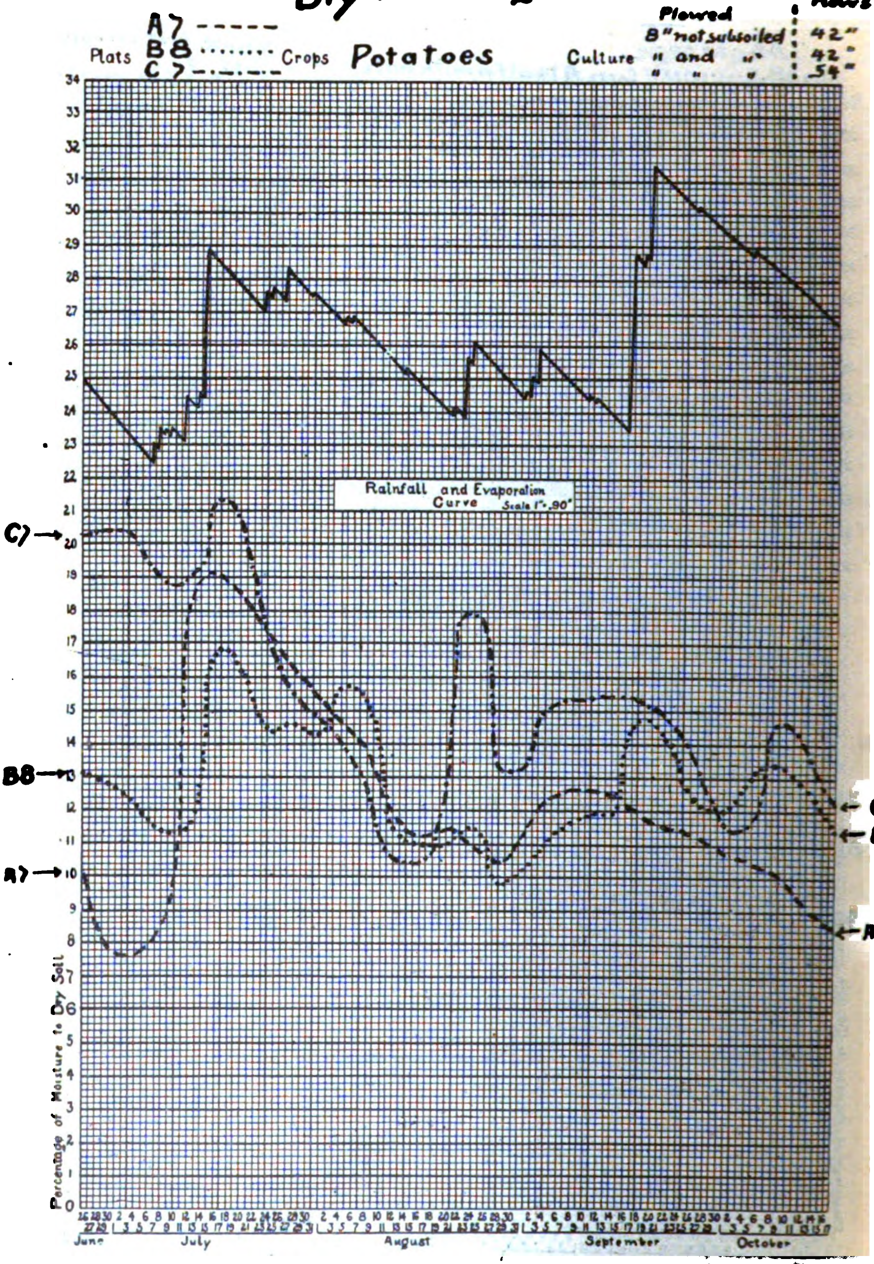


Plate 8 Dry Farming

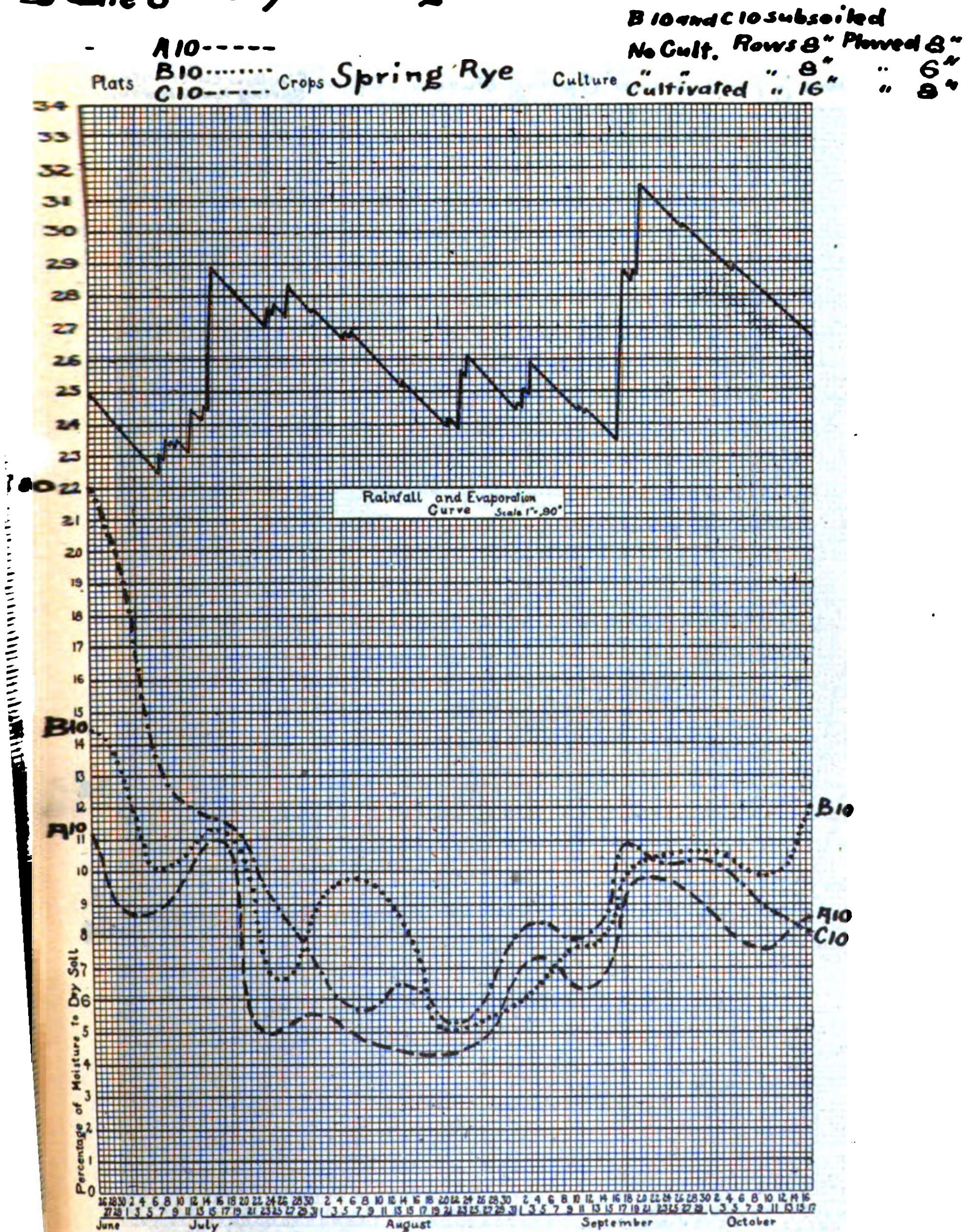


Plate 9 Dry Farming.

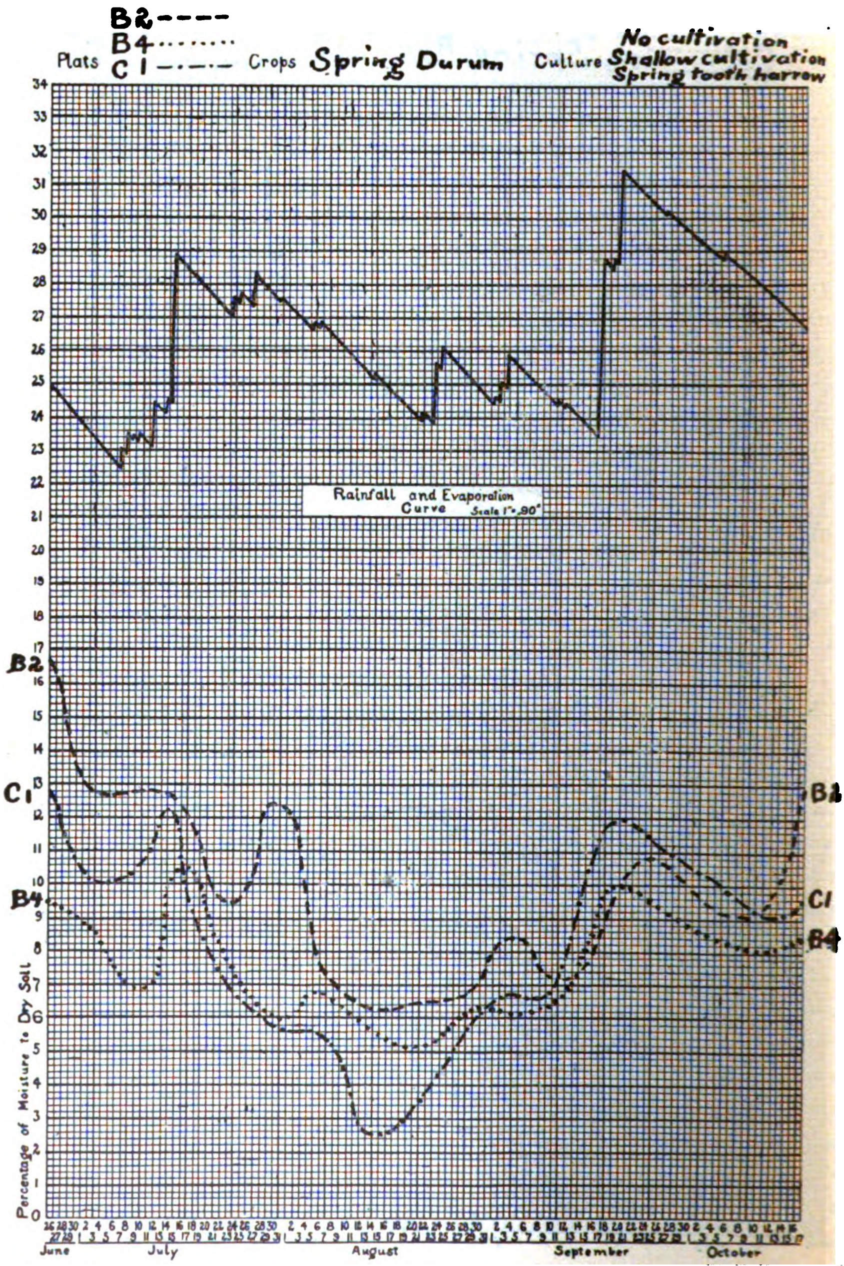
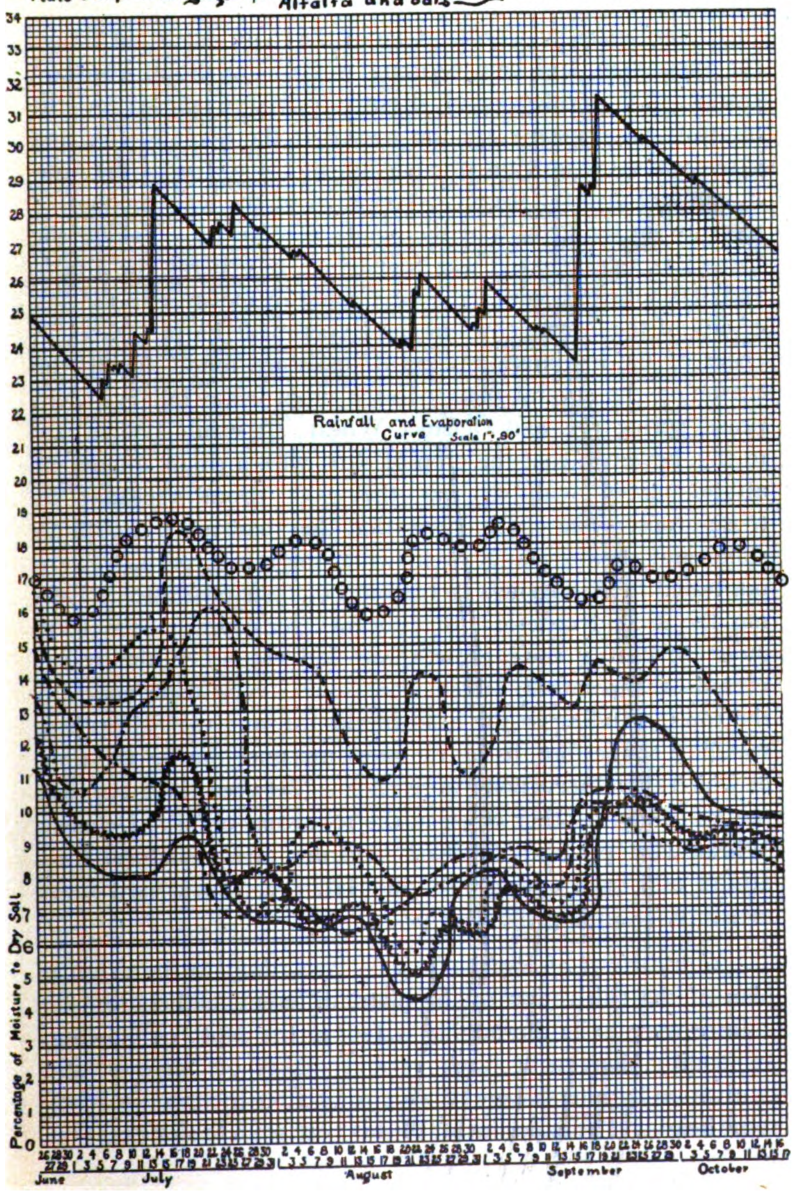


Plate 10 Dry Farming

Fallowed oooooo

All plats of each
Plats crop averaged Crops

Field Pease .... 1 plat irrigated July 10
Potatoes --------
Spring rye -.-.-.-.-
Defiance wheat -..-..- 3 plats " " "
Fall rye ~~~~~~~~ Culture Averaged for each crop
Alfalfa and oats ~



PRELIMINARY DEDUCTIONS.

Comparison of Crops.—One of the most important things for success in arid land farming is growing drouth-resistant plants. The evidences of drouth resistance shown by the moisture experiments are the power of the plant to live and grow while the amount of moisture in the soil is at the minimum, and also the use or evaporation of the least amount of moisture in the growth of the plants to maturity. Taking the former as a criterion, it was found that, in general, the alfalfa and oats subsisted with the least amount of moisture in the soil of any of the crops grown at the Experiment Farm. Next, in order of the minimum amount of moisture found during the season in the several plats of each crop, came fall rye, field pease, spring rye, and Defiance Wheat. It would not be fair to say, however, that the crop of oats, with a small amount of alfalfa mixed with it, was the most drouth-resistant of these crops. The charts show that they had more drouth to stand and stood it fairly well, while the others perhaps were not tested by the dryness to the limit of their resistance. Taking the second criterion, that of the crops which used least moisture during their growth, we find the order almost reversed—the potatoes, which were sowed very wide apart in the rows, standing at the head of the list, and the field pease, standing at the foot, using the most moisture during the time in which the observations were taken. Between these two extremes came the other crops in the following order: Defiance Wheat used perhaps the least moisture after potatoes, then alfalfa and oats, spring rye, and fall rye, which used most moisture, excepting the field pease.

Comparison of Soil Cultures.—According to the original plan of the cultivation of the plats, different methods of soil culture were to be thoroughly tested, in the depth of plowing, sub-soiling, harrowing with various makes of harrows, and cultivation by inter-tillage in wide rows after the grain reached some height. The experiments of this year seem to show that the

deep plowing was beneficial, but the sub-soiling did not have any apparent effect, and that the shallow cultivation produced better results in retaining the moisture than did the deep cultivation. The more thinly planted crops naturally retained much more moisture throughout the season than those more thickly planted, and on the plats where the same amount of grain per acre were planted in 8-inch and 16-inch rows, the plats planted in 8-inch rows retained more moisture than those in 16-inch rows, possibly because the grain was much thicker in the 16-inch rows than in the others. Much of the cultivation was not carried out as thoroughly as was planned in the beginning, probably because of the large number of plats and the lack of time and men. These deductions, as indicated in the sub-head, are only preliminary, and before they are taken as authoritative they should be corroborated or disproved by subsequent tests.

COMPARISON OF SOIL MOISTURE WITH YIELD.

Full-face figures indicate monthly determinations; others, weekly.

Plat No.	CROP	Maximum per cent		Minimum per cent		Mean per cent	Yield per acre, lbs.
		Date	Amt.	Date	Amt.		
A-1	Field Pease	July 17	17.7	July 31	4.4	9.4	420
A-2	Defiance Wheat	" 24	19.1	Oct. 17	6.5	12.5	1854
A-3	" "	" 10	18.0	Aug. 21	2.7	9.4	1354
A-4	" "	" 25	**7.4**	" 28	**5.9**	....	1400
A-5	Alfalfa with nurse crop	Sept. 24	**8.2**	" 29	**4.6**	....	909
A-6	" " " "	July 17	10.1	" 21	2.9	6.6	
A-7	Potatoes	" 17	19.0	July 3	7.6	12.1	4620
A-8	"	" 25	**15.2**	Sept. 24	**12.7**	....	
A-9	Fall Rye	June 26	11.5	Aug. 21	4.1	7.1	544
A-10	Spring Rye	" 26	11.2	" 21	4.3	7.5	1404
B-1	Field Pease	June 26	16.3	Aug. 21	6.0	10.4	950
B-2	Spring Durum	" 26	16.8	" 14	6.3	10.1	1645
B-3	" "	Sept. 14	**10.9**	" 29	**7.2**	....	1385
B-4	" "	July 17	10.5	" 21	5.2	7.6	1331
B-7	Potatoes	" 25	**18.4**	" 29	**12.8**	....	5390
B-8	"	" 17	16.8	" 28	9.8	12.6	
B-9	Fall Rye	Oct. 2	14.3	" 21	4.5	9.8	491
B-10	Spring Rye	June 26	14.4	" 21	5.1	9.4	1246
C-1	Spring Durum	July 10	12.2	Aug. 14	2.6	7.5	1396
C-2	" "	Sept. 24	**7.4**	" 29	**6.1**	....	1296
C-3	" "	" 25	**8.4**	July 25	**5.5**	....	1344
C-4	" "	" 25	**9.1**	" 25	**6.1**	....	
C-7	Potatoes	July 17	21.3	Aug. 14	10.4	15.9	3190
C-8	"	" 25	**20.6**	" 29	**6.7**	....	
C-9	Fall Rye	Sept. 25	**8.4**	" 29	**4.2**	....	802
C-10	Spring Rye	June 26	22.1*†	" 21	5.3	9.1	930
D-1	Defiance Wheat	July 24	11.8	Aug. 21	5.3	7.7	1352
D-2	Silver King Wheat	June 26	22.5*‡	" 28	4.5	8.4	1190
D-3	Defiance Wheat	July 17	12.8	" 21	5.8	9.3	1250
D-4	Winter Rye	" 3	16.9*	" 21	6.8	10.4	790
D-5	Spring Rye	June 26	**22.3***	July 26	**7.9**	....	452
D-8	Potatoes	July 26	**20.4**	June 26	**8.5**	....	4050
D-9	"	" 26	**17.7**	Sept. 25	**12.7**	....	
D-10	Field Pease	Sept. 25	**10.5**	Aug. 30	**6.4**	....	1058
E-4	Defiance Wheat	Aug. 30	**11.5**	Sept. 25	**9.6**	....	1222
E-6	Potatoes	Sept. 26	**8.5**	Aug. 30	**4.1**	....	4950
E-8	Field Pease	" 25	**10.6**	" 30	**5.9**	....	508

NOTE.—Yield was not weighed or samples not taken on plats that are omitted.

*Damper than average at this time.
†Next highest July 3—17.2 per cent.
‡Next highest July 3—13.2 per cent.

PERCENTAGE MOISTURE TO DRY SOIL.

Laboratory determinations made by F. E. Hepner, Assistant Chemist.
*Indicates a probability that sample was taken in a part of plat damper than the average.—H. T. N.

	PLAT A1 FIELD PEASE				PLAT A2 DEFIANCE WHEAT			
DATE	1	2	3	Av.	4	5	6	Av.
June 26, 1906	....	....	17.4	17.4	18.3	....	....	18.3
July 3	14.1	17.7	16.9	16.2	9.0	13.9	11.1	11.3
July 10	13.7	17.1	19.4	16.7	11.4	12.6	11.3	11.8*
July 12	....	....	....	....	10.6	10.0	11.0	10.5
July 17	14.0	14.3	24.7	17.7	12.6	12.9	12.0	12.5
July 24	7.1	11.5	10.4	9.7	21.8	21.5	13.9	19.1
July 31	3.5	6.5	3.7	4.6	13.1	17.6	12.2	14.3
August 7	13.0	10.0	3.7	8.9	12.7	16.1	10.4	13.1
August 14	8.1	8.8	7.3	8.1	13.9	15.4	9.4	12.9
August 21	4.0	5.0	7.1	5.4	12.6	16.5	12.3	13.8
August 28	2.7	5.9	5.5	4.7	9.9	16.4	13.4	13.2
September 4	4.9	8.4	6.9	6.7	10.0	15.6	12.8	12.8
September 11	6.8	6.0	7.4	6.7	9.4	13.9	11.4	11.6
September 18	8.1	6.9	10.2	8.4	12.4	13.1	10.7	12.1
September 25	10.5	8.4	6.6	8.5	13.4	15.2	11.0	13.2
October 2	7.6	5.5	7.1	6.7	11.2	13.1	5.1	9.8
October 10	8.6	6.7	7.0	7.4	11.2	9.4	5.2	8.6
October 17	5.9	8.2	6.9	7.0	6.5	7.4	5.7	6.5

	PLAT A3 DEFIANCE WHEAT				PLAT A4 DEFIANCE WHEAT			
	7	8	9	Av.	10	11	12	Av.
June 26, 1906	11.7	10.8	10.6	11.0	13.2	11.8	11.7	12.2
July 3	6.6	8.3	14.4	9.8	4.7	8.1	6.2	6.3
July 10	29.6	14.2	10.2	18.0	6.0	11.3	9.0	8.8
July 12	18.8	17.6	11.7	16.0	....	....	....	....
July 17	10.5	10.1	14.7	11.8	15.5	21.2	18.8	18.5
July 24	5.9	9.1	6.6	7.2	8.8	15.5	11.2	11.8
July 31	11.9	15.2	12.0	13.0	7.6	12.7	13.3	7.9
August 7	5.6	6.7	4.6	5.6	7.3	11.1	6.4	8.3
August 14	5.9	6.9	5.7	6.2	6.5	10.8	5.2	7.5
August 21	2.0	2.3	3.9	2.7	6.0	6.5	5.3	5.9
August 28	4.8	6.0	6.5	5.6	4.2	4.9	5.8	5.0
September 4	4.5	7.3	7.1	6.3	4.7	7.8	8.4	7.0
September 11	5.6	7.1	5.9	6.2	2.9	5.5	7.1	5.2
September 18	7.8	10.0	7.5	8.4	10.6	7.4	9.5	9.2
September 25	9.8	9.3	6.5	8.5	9.6	6.9	8.9	8.5
October 2	10.1	9.7	6.8	8.9	9.4	7.6	5.4	7.5
October 10	8.7	8.8	4.5	7.3	8.8	8.9	5.3	7.7
October 17	8.5	9.7	5.2	7.8	7.9	8.0	3.8	6.6

	PLAT A6 ALFALFA WITH OAT NURSE CROP				PLAT A7 POTATOES			
	13	14	15	Av.	16	17	18	Av.
June 26, 1906	8.7	10.1	....	9.4	....	....	....	....
July 3	4.1	4.7	5.7	4.8	10.1	9.5	13.2	7.6
July 10	7.1	5.3	5.5	6.0	9.6	11.5	9.9	10.3
July 17	7.9	10.6	11.9	10.1	16.1	19.3	21.5	19.0
July 24	5.7	6.7	7.1	6.5	19.0	16.3	16.6	17.3
July 31	6.1	5.8	5.0	5.6	13.5	16.2	16.7	15.5
August 7	6.5	7.2	7.1	6.9	9.4	17.1	15.6	14.0
August 14	4.4	4.9	4.5	4.6	11.4	12.8	9.8	11.3
August 21	3.2	2.4	3.0	2.9	11.8	13.2	9.5	11.5
August 28	4.7	4.9	5.3	5.0	9.3	12.2	9.9	10.5
September 4	4.7	5.0	6.5	5.4	10.2	14.6	12.0	12.3
September 11	5.0	6.3	7.8	6.4	11.5	15.2	11.1	12.6
September 18	8.8	8.3	7.4	8.2	14.0	13.1	8.5	11.9
September 25	10.6	8.6	8.5	9.2	13.7	11.3	9.3	11.4
October 2	7.7	6.7	6.3	6.9	14.5	15.6	10.2	13.4
October 3 a	....	....	....	....	12.9	11.2	7.8	10.6
October 3 b	....	....	....	....	15.4	12.4	7.6	11.8
October 3 c	....	....	....	....	10.4	10.8	10.1	10.4
October 10	9.7	7.3	6.5	7.8	13.0	10.1	6.5	9.9
October 17	6.5	6.9	5.9	6.4	10.3	9.1	6.2	8.4

	PLAT A9 WINTER RYE				PLAT A10 SPRING RYE			
	19	20	21	Av.	22	23	24	Av.
June 26, 1906	12.5	10.4	11.6	11.5	....	10.6	11.8	11.2
July 3	5.3	7.4	6.4	6.4	8.4	8.4	8.9	8.6
July 10	7.2	7.3	7.9	7.5	12.5	11.0	9.2	10.9
July 17	8.9	7.4	6.0	7.4	9.8	10.4	9.1	9.8
July 24	7.7	7.0	6.8	7.5	4.5	5.4	5.2	5.0
July 31	7.2	5.1	5.5	5.9	5.4	6.2	5.2	5.6
August 7	8.8	5.3	6.0	4.9	6.3	4.6	3.9	4.9
August 14	8.8	6.3	5.2	6.6	5.7	3.7	3.9	4.4
August 21	4.0	3.8	4.6	4.1	6.0	3.6	3.4	4.3
August 28	6.6	6.4	7.2	6.7	5.8	5.4	4.5	5.2
September 4	9.1	7.1	8.3	8.2	7.9	7.5	6.6	7.3
September 11	5.7	4.6	5.2	5.2	5.9	6.1	7.0	6.3
September 18	9.9	9.0	6.1	8.3	11.8	9.4	7.6	9.6
September 25	12.1	7.9	5.9	8.6	12.5	9.0	7.5	9.7
October 2	11.8	7.3	5.8	8.3	11.8	7.9	5.7	8.5
October 10	9.3	5.9	5.1	6.8	10.9	7.1	4.8	7.6
October 17	6.3	7.1	5.2	6.2	12.1	8.2	5.5	8.6

	PLAT B1 FIELD PEASE				PLAT B2 SPRING DURUM			
	25	26	27	Av.	28	29	30	Av.
June 26, 1906	....	15.7	17.0	16.3	....	16.8	....	16.8
July 3	8.8	14.0	14.5	12.4	10.7	14.1	13.7	12.8
July 10	9.9	14.1	15.9	13.3	12.0	15.1	11.7	12.9
July 17	9.1	13.1	13.5	11.9	11.2	12.8	12.4	12.1
July 24	6.6	11.8	9.6	9.3	8.9	10.3	9.3	9.5
July 31	6.9	10.4	9.5	8.9	12.2	12.8	12.3	12.4*
August 7	11.8	10.3	9.0	10.4	7.6	9.7	4.5	7.3
August 14	5.5	11.5	8.5	8.5	8.8	5.0	5.1	6.3
August 21	4.0	6.0	8.0	6.0	8.6	5.2	5.7	6.5
August 28	9.7	9.3	6.4	8.5	6.3	6.4	7.4	6.7
September 4	7.6	10.7	10.2	9.5	7.6	6.9	10.8	8.4
September 11	7.2	8.8	8.7	8.2	5.2	7.2	8.8	7.1
September 18	13.0	11.6	10.0	11.5	10.9	10.9	8.2	10.0
September 25	12.6	10.9	7.2	10.2	12.0	11.4	9.2	10.9
October 2	11.7	13.5	7.8	11.0	11.7	11.1	6.0	9.6
October 10	12.8	10.2	8.4	10.5	13.5	9.9	4.3	9.2
October 17	12.5	10.1	8.4	10.3	11.3	10.6	6.9	12.9

	PLAT B4 SPRING DURUM				PLAT B5—ALFALFA WITH OAT NURSE CROP			
	31	32	33	Av.	34	35	36	Av.
June 26, 1906	....	10.1	8.9	9.5	10.9	11.6	11.6	11.4
July 3	8.5	9.0	8.3	8.6	8.9	9.4	11.8	10.0
July 10	6.6	6.6	7.2	6.8	7.1	9.4	8.6	8.4
July 17	12.0	10.3	9.2	10.5	9.3	9.2	14.0	10.8
July 24	5.8	5.9	8.4	6.7	8.5	12.0	8.3**	9.6
July 31	4.7	6.5	6.4	5.9	8.2	11.5	11.4	10.4
August 7	5.2	8.2	6.5	6.6	6.6	8.7	3.5**	6.3
August 14	5.3	5.0	6.4	5.6	9.5	11.2	6.8	9.2
August 21	3.2	5.5	6.8	5.2	6.6	7.7	5.6	6.6
August 28	5.7	6.0	6.7	6.1	8.0	8.5	9.6	8.7
September 4	5.3	6.7	6.7	6.2	6.4	9.7	16.2	10.8
September 11	6.5	7.7	7.6	7.3	5.3	6.8	9.1	7.1
September 18	9.9	11.4	8.0	9.8	10.4	10.6	10.2	10.4
September 25	9.6	10.6	8.4	9.5	13.6	9.0	10.2	10.9
October 2	9.9	10.0	6.0	8.6	11.6	12.1	8.4	10.7
October 10	9.7	9.2	5.4	8.1	11.9	11.5	8.6	10.7
October 17	9.2	8.6	7.5	8.4	10.8	11.2	7.7	9.9

**Bottle was broken, though part of sample was saved. There was a chance to lose some water.

	PLAT B8 POTATOES				PLAT B9 FALL RYE			
	37	38	39	Av.	40	41	42	Av.
June 26, 1906	....	18.1	....	18.1	12.9	15.8	10.6	13.1
July 3	11.0	12.1	14.0	12.4	7.4	9.8	15.5	10.9
July 10	10.8	11.0	12.5	11.3	7.6	8.3	10.4	8.8
July 17	15.3	11.2	24.0	16.8	8.4	11.0	13.7	11.0
July 24	11.0	7.8	24.6	14.5	5.3	8.2	10.8	8.1
July 31	9.5	12.1	21.1	14.2	5.4	9.7	8.5	7.9
August 7	12.0	18.1	16.7	15.6	7.9	9.3	7.4	8.2
August 14	6.5	8.8	18.1	11.1	7.8	8.0	8.5	7.9
August 21	9.8	15.2	13.0	12.7	4.0	5.2	4.4	4.5
August 28	9.5	9.6	10.4	9.8	7.6	10.3	7.2	8.4
September 4	9.0	10.5	13.8	11.1	6.0	6.4	11.2	7.9
September 11	7.4	10.6	21.0	13.0	4.2	9.3	12.0	8.5
September 18	12.3	11.1	21.6	15.0	8.2	9.5	13.7	10.5
September 25	14.8	12.6	8.3	11.9	13.0	14.0	12.5	13.2
October 2	11.6	12.6	7.9	10.7	13.4	18.6	10.9	14.3
October 10	12.5	14.9	12.5	13.3	9.3	10.2	11.1	10.2
October 17	10.9	13.0	10.3	11.4	10.8	14.2	14.5	13.2

	PLAT B10 SPRING RYE				PLAT C1 SPRING DURUM			
	43	44	45	Av.	46	47	48	Av.
June 26, 1906	14.6	14.5	14.2	14.4	....	....	....	....
July 3	8.7	12.6	13.9	11.7	6.0	10.7	13.5	10.1
July 10	6.7	12.8	11.8	10.8	11.9	13.6	11.1	12.2
July 17	12.1	12.8	9.0	11.3	5.9	12.6	10.9	9.8
July 24	6.9	6.9	6.6	6.8	4.9**	6.9	9.3	7.0
July 31	10.7	9.0	7.0	8.9	5.6	5.9	6.0	5.8
August 7	9.7	10.7	9.1	9.8	6.0	6.9	3.4	5.4
August 14	6.9	9.8	8.4	8.4	1.9	4.3	1.7	2.6
August 21	5.3	4.3	5.8	5.1	3.8	3.3	3.6	3.6
August 28	4.8	5.3	6.5	5.5	6.1	6.1	6.4	6.2
September 4	4.9	8.3	6.3	6.5	4.6	6.9	8.5	6.7
September 11	6.8	7.0	9.2	7.7	3.0	8.5	9.7	7.1
September 18	8.5	9.7	12.2	10.1	12.1	11.2	11.8	11.7
September 25	11.0	9.1	11.5	10.5	10.7	11.0	8.0	9.9
October 2	11.2	11.6	8.7	10.5	10.6	8.8	19.4††	10.4
October 10	10.7	10.0	9.0	9.9	8.9	9.8	8.5	9.1
October 17	11.2	13.5	11.7	12.1	11.0	9.2	8.0	9.4

**Bottle broken; part of sample saved.

††I think there was a mistake in recording a weight and that the per cent should be 11.3.—F. E. H.

	PLAT C6 ALFALFA AND OAT NURSE CROP				PLAT C7 POTATOES			
	49	50	51	Av.	52	53	54	Av.
June 26, 1906	....	18.0	13.3	13.1	....	20.2	....	20.2
July 3	9.2	18.4	19.3	14.3	16.6	22.4	21.8	20.3
July 10	10.3	15.9	15.5	13.9	15.4	20.8	19.9	18.7
July 17	10.7	13.9	18.5	14.4	18.7	20.5	24.6	21.3
July 24	5.8	7.9	10.8	8.2	17.5	22.2	12.3	17.3
July 31	10.8	12.1	5.2	8.7	10.3	15.0	19.6	15.0
August 7	5.4	8.9	5.2	6.5	10.8	17.8	10.9	13.2
August 14	6.5	8.8	5.5	6.9	9.7	11.0	10.6	10.4
August 21	6.3	5.0	6.3	5.9	7.1	11.2	15.7	18.0*
August 28	4.4	6.8	7.1	5.9	10.5	13.5	17.0	13.3
September 4	6.4	10.6	8.5	8.5	13.4	14.7	17.0	15.0
September 11	4.8	8.2	8.9	7.8	12.8	16.9	17.1	15.4
September 18	8.8	9.7	9.6	9.2	11.9	14.2	19.9	15.3
September 25	10.5	9.7	10.9	10.4	12.3	15.4	14.8	14.2
October 2	11.4	9.4	7.7	9.5	9.7	11.2	13.3	11.4
October 10	....	....	....	....	10.6	16.6	16.6	14.6
October 11	10.4	9.4	4.9	8.2	....	....	....	....
October 17	7.1	11.0	8.8	9.0	11.8	14.0	11.3	12.4

	PLAT C10—SPRING RYE				FALLOW			
	55	56	57	Av.	58	59	60	Av.
June 26, 1906	18.4	24.4	23.4	22.1*	15.1	14.8	13.8	14.6
July 3	11.8	18.7	21.1	17.2	7.8	8.9	14.9	10.5
July 10	9.2	15.4	11.9	12.2	14.5	20.8	19.1	18.1
July 17	10.9	11.6	10.2	10.9	13.0	17.0	23.3	17.8
July 24	5.7	10.7	11.5	9.3	13.0	18.5	20.8**	17.4
July 31	7.4	8.2	6.2	7.8	9.9††	23.9	18.0	17.3
August 7	4.5	5.5	7.1	5.7	17.9	22.7	13.4	18.0
August 14	8.6	5.8	5.1	6.5	12.7	20.8	15.0	16.0
August 21	5.0	4.1	6.9	5.3	18.2	20.1	16.8	18.4
August 28	4.8	7.1	8.1	6.5	15.6	21.5	16.5	17.9
September 4	7.1	9.7	9.4	8.4	13.5	24.9	17.3	18.6
September 11	5.9	9.3	8.6	7.9	16.9	21.7	13.1	17.2
September 18	11.0	11.1	10.2	10.8	13.7	14.4	20.4	16.2
September 25	12.4	11.0	7.1	10.2	15.2	19.7	16.6	17.2
October 2	12.1	12.4	6.5	10.3	14.6	23.1	13.3	17.0
October 10	....	....	....	....	17.6	19.5	16.2	17.8
October 11	11.2	9.7	6.6	8.8	....	....	....	....
October 17	9.3	8.7	6.3	8.7	13.5	19.3	16.5	16.8

**Bottle broken; part of sample saved.

††Bottle broken; sample saved.

	PLAT D1 DEFIANCE WHEAT				PLAT D2 SILVER KING WHEAT			
	61	62	63	Av.	64	65	66	Av.
June 26, 1906	11.5	12.4	11.5	11.8	....	....	22.5	22.5*
July 3	8.2	9.0	7.2	8.1	9.4	19.0	11.2	13.2
July 10	8.4	8.3	7.5	8.1	5.5	6.0	6.3	5.9
July 17	7.5	6.2	7.7	7.1	8.7	6.7	6.5	7.3
July 24	5.2	8.7	11.8	8.6	7.4	6.3	6.3	6.7
July 31	4.8	5.7	7.6	6.0	4.4	4.1	7.2	5.2**
August 7	5.3	7.3	8.5	7.0	4.5	4.4	6.6	5.2
August 14	5.2	6.4	7.6	6.4	3.6	5.6	5.1	4.8
August 21	4.2	4.8	5.3	4.8	4.9	6.3	5.8	5.7
August 28	4.5	5.1	6.5	5.4	4.0	5.1	4.4	4.5
September 4	5.3	5.2	7.2	5.9	5.9	6.1	9.5	7.2
September 11	4.2	5.5	7.8	5.8	5.0	6.5	10.7	7.4
September 18	11.4	8.3	10.5	10.1	12.1	7.8	10.8	10.2
September 25	10.0	7.4	10.0	9.1	12.3	10.0	10.9	11.1
October 3	11.6	9.6	7.2	9.5	11.6	8.8	8.2	9.5
October 11	8.8	8.3	6.6	7.9	9.3	9.6	6.0	8.5
October 17	10.7	9.0	8.1	9.3	9.4	7.1	7.6	8.0

**This doesn't look right, but from the figures I can't see how a mistake had been made in reading.—F. E. H.

	PLAT D3 DEFIANCE WHEAT				PLAT D4 WINTER RYE			
	67	68	69	Av.	70	71	72	Av.
June 26, 1906	11.8	9.3	10.7	10.6	11.7	9.7	7.4	9.6
July 3	8.3	10.0	19.5	12.6	14.2	21.9	14.7	16.9*
July 10	8.6	8.9	9.5	9.0	8.2	7.7	7.0	7.6
July 17	9.7	10.8	17.7	12.8	11.1	9.7	15.9	12.2
July 24	6.5	11.2	7.8	8.5	7.3	6.1	9.2	7.5
July 31	8.3	13.0	9.9**	10.4	8.3	9.9	8.3	8.8
August 7	7.0	9.2	7.1	7.8	10.3	11.8	8.7	10.3
August 14	6.3	10.2	9.7	8.7	9.0	11.5	7.6	9.4
August 21	7.0	6.0	4.5	5.8	6.7	6.7	7.1	6.8
August 28	4.4	6.9	7.1	9.5	10.0	10.4	8.6	9.7
September 4	7.8	10.2	7.5	8.5	8.0	7.1	9.4	8.2
September 11	5.7	9.9	9.0	8.2	8.7	10.7	8.7	9.4
September 18	7.6	8.8	8.1	8.2	12.1	23.4**	....	12.2
September 25	13.6	8.7	8.8	10.4	12.0	12.3	8.1	10.8
October 3	12.4	10.9	7.9	10.4	13.4	12.2	7.7	11.1
October 11	10.3	8.5	6.0	8.3	13.8	11.9	8.6	11.4
October 17	9.7	8.5	6.7	8.3	11.9	10.1	6.4	9.5

**Bottle broken; sample saved.

**It is very evident that a mistake was made in reading a weight, and from the figures recorded I think the per cent should read 12.0.—F. E. H.

	PLAT D7 TURKESTAN ALFALFA			PLAT D8 POTATOES		
	73	74	75	76	77	78
June 26, 1906	18.5	12.2	11.7	11.0	....	7.6
July 26	9.9	10.3	9.0	16.5	26.8	18.8
August 28	5.2	6.2	7.0	10.9	16.2	12.2
September 25	9.5	8.2	8.8	13.7	16.0	12.2

	PLAT D5 SPRING RYE			PLAT A5—ALFALFA WITH OAT NURSE		
	79	80	81	82	83	84
June 26, 1906	....	....	22.3*	....	....	....
July 25	....	....	....	8.4**	11.0	12.6
July 26	6.6	7.8	10.4	....	....	....
August 28	8.2	11.8	8.8	5.0	3.9	7.0
September 24	....	....	....	10.3	7.4	6.2
September 25	13.4	10.7	7.9	....	....	....

**Lost some.—F. E. H.

	PLAT A7 POTATOES			PLAT A1 FIELD PEASE		
	85	86	87	88	89	90
July 25 1906	10.0	11.3	18.8	8.5	7.0	7.2
August 28	7.9	8.4	7.8	6.2	6.8	7.6
September 24	9.2	8.4	7.8	13.9	9.2	4.4

	PLAT A2 DEFIANCE WHEAT			PLAT A3 DEFIANCE WHEAT		
	91	92	93	94	95	96
July 25, 1906	3.7	3.5	3.4	4.1	12.3	10.1
August 28	5.6	5.0	7.0	7.0	5.3	5.6
September 24	9.0	5.8	4.4	11.4	7.1	5.8

	PLAT A4 DEFIANCE WHEAT			PLAT A5 ALFALFA & OATS		
	97	98	99	100	101	102
July 25, 1906	8.0	7.2	6.9	6.9	7.7	8.4
August 28	6.6	6.0	5.1	....	....	....
August 29	....	....	....	4.0	4.9	4.9
September 24	9.6	5.8	4.3	10.8	6.9	6.8

	PLAT A6 ALFALFA AND OATS			PLAT A7 POTATOES		
	103	104	105	106	107	108
July 25, 1906	7.6	7.5	10.4	5.7	6.1	6.9
August 29	7.4	8.8	7.8	2.6	4.0	5.1
September 24	11.1	9.5	7.0	7.6	6.5	7.6

	PLAT A8 POTATOES			PLAT A9 WINTER RYE		
	109	110	111	112	113	114
July 25, 1906	10.5	14.2	20.9	3.8	5.7	4.8
August 29	7.7	10.7	14.8	7.0	7.2	6.3
September 24	9.0	11.0	12.7	12.1	10.2	9.2

	PLAT A10 SPRING RYE			PLAT B3 SPRING DURUM		
	115	116	117	118	119	120
July 25, 1906	8.2	7.1	5.0	8.8	8.4	8.6
August 29	6.1	6.2	7.8	6.7	7.8	7.0
September 24	11.9	8.0	7.1	15.1	7.5	10.0

	PLAT B6 ALFALFA AND OATS			PLAT B7 POTATOES		
	121	122	123	124	125	126
July 25, 1906	8.8	14.2	10.1	10.0	19.0	26.1
August 29	5.9	8.4	8.6	10.1	13.2	14.4
September 24	11.2	10.1	9.1	12.7	18.2	12.4

	PLAT C2 SPRING DURUM			PLAT C3 SPRING DURUM		
	127	128	129	130	131	132
July 25, 1906	7.3	7.6	6.0	5.9	5.5	5.2
August 29	5.9	6.8	5.6	3.7	5.6	3.3
September 24	9.7	6.2	6.5	....	.....	....
September 25	....	....	....	11.3	9.5	4.4

	PLAT C5 ALFALFA AND OATS			PLAT C8 POTATOES		
	133	134	135	136	137	138
July 25, 1906	9.0	13.8	10.0	14.8	23.1	22.0
August 29	5.0	9.1	8.7	5.8	6.8	9.5
September 25	12.3	11.6	10.9	10.1	9.7	10.9

	PLAT C4 SPRING DURUM			PLAT C9 WINTER RYE		
	139	140	141	142	143	144
July 25, 1906	2.8	3.2	7.4	4.3	8.4	10.0
August 29	7.4	9.4	9.2	3.8	4.4	4.5
September 25	10.2	8.6	9.2	8.6	6.5	10.1

	PLAT B1 FIELD PEASE			PLAT B2 SPRING DURUM		
	145	146	147	148	149	150
July 25, 1906	3.5	4.2	5.3	2.1	4.8	6.6
August 29	3.1	2.9	3.7	3.0	3.8	3.6
September 25	7.9	3.8	3.6	9.8	7.5	7.2

	PLAT B5 ALFALFA AND OATS			PLAT B6 ALFALFA & OATS		
	151	152	153	154	155	156
July 26, 1906	6.1	7.0	5.4	7.8	8.2	7.3
August 29	6.5	4.4	4.8	4.6	5.3	7.2
September 25	10.9	7.9	7.0	12.7	8.3	6.4

	PLAT B7 POTATOES			PLAT B8 POTATOES		
	157	158	159	160	161	162
July 26, 1906	10.6	11.9	10.3	10.3	9.9	10.1
August 29	8.8	6.5	3.6	2.9	3.2	2.8
September 25	9.5	7.8	4.9	11.6	7.6	6.0

	PLAT B9 SOUTH FALL RYE			PLAT B10 SOUTH SPRING RYE		
	163	164	165	166	167	168
July 26, 1906	3.7	5.9	4.4	8.3	7.6	5.1
August 29	3.5	2.3	1.8	3.5	3.8	3.0
September 25	9.9	4.5	1.8	7.7	4.6	1.6

	PLAT C5 ALFALFA AND OAT NURSE			PLAT C6–ALFALFA WITH OAT NURSE		
	169	170	171	172	173	174
July 26, 1906	4.7	6.6	6.6	6.6	5.9	5.6
August 29	4.7**	4.4	4.4	3.9	3.6	3.1
September 25	13.5	5.1	3.6	10.2	3.9	3.3

**There was a very evident mistake in recording, upon correcting which the above is given.—F. E. H.

	PLAT C7 POTATOES			PLAT C8 POTATOES		
	175	176	177	178	179	180
July 26, 1906	16.3	13.2	13.5	15.2	13.4	12.9
August 29	11.2	7.9	6.9	11.3	7.6	9.1
September 25	11.9	10.1	8.5	14.7	10.6	7.0

	PLAT C9 FALL RYE			PLAT C10 SPRING RYE		
	184	185	186	187	188	189
July 26, 1906	12.4	6.5	5.9	13.1	10.9	6.9
August 29	3.6	3.6	4.0	3.7	3.9	2.8
September 25	12.8	7.3	6.3	9.3	6.8	5.5

	PLAT C1 SOUTH SPRING DURUM			SOUTH SUMMER FALLOW		
	190	191	192	193	194	195
July 26, 1906	6.3	7.4	3.0	21.1	13.9	9.3
August 29	2.9	1.7	1.2	16.2	13.9	9.0
September 25	7.6	5.3	3.5	....	....	....
September 26	....	....	....	21.5	18.2	12.6

	PLAT C2 SOUTH SPRING DURUM			PLAT C3 SOUTH SPRING DURUM		
	196	197	198	199	200	201
July 26, 1906	9.2	11.0	9.5	4.6	8.2	6.6
August 29	2.9	3.2	3.1	4.4	2.5	2.0
September 26	6.9	4.8	1.6	10.8	12.8	9.0

	PLAT C4 SOUTH SPRING DURUM			PLAT D9 POTATOES		
	202	203	204	205	206	207
July 26, 1906	8.6	5.4	4.2	11.4	19.2	23.6
August 29	2.9**	3.6	3.7	....	....	....
August 30	....	....	....	7.3	12.1	18.8
September 25	....	....	....	12.0	13.8	22.1
September 26	12.2	7.1	5.7	....	....	....

**A very evident mistake was made in recording a weight. Making the correction apparent gives the above.—F. E. H.

	PLAT D10 FIELD PEASE			PLAT D10 NORTH 2 FIELD PEASE		
	208	209	210	211	212	213
July 26, 1906	8.8	10.4	10.9	6.9	14.9	9.9
August 30	4.7	5.7	8.7	6.1	6.9	8.2
September 25	11.3	10.3	8.3	11.0	7.4	11.5

	PLAT D10 NORTH 3 FIELD PEASE			PLAT D10 SOUTH FIELD PEASE		
	214	215	216	217	218	219
July 26, 1906	8.7	9.2	8.2	5.4	6.5	8.9
August 30	6.3	7.4	7.5	5.0	4.6	6.1
September 25	14.0	9.1	11.8	11.4	10.2	10.0

	PLAT E10 NORTH TURKESTAN ALFALFA			PLAT E8 NORTH FIELD PEASE		
	220	221	222	223	224	225
August 30, 1906	4.4	4.7	4.8	5.3	5.1	5.9
September 25	6.2	5.6	10.7	11.5	8.5	11.7

	PLAT E6 NORTH POTATOES			PLAT E4 NORTH DEFIANCE WHEAT		
	226	227	228	229	230	231
August 30, 1906	3.9	4.3	4.1	10.8	10.7**	13.1
September 25	....	....	....	11.6	9.7	7.5
September 26	8.9	9.1	7.4	....	....	....

**A mistake in recording weight, which corrected gives above.—F. E. H.

SOIL MOISTURE WORK FOR THE SEASON OF 1907.

Work was started on the irrigation extension moisture experiments at the Cheyenne Demonstration Farm in April, 1907. The plan of these determinations is slightly different from that of the season of 1906. In 1906 it was necessary, in order to collect the samples all on one day, to have an assistant one day each week, and in 1907 it was not thought advisable to go to this additional expense, so the work had to be reduced in scope somewhat. On consultation with the Director of the Experiment Station and the Chief of the Central Division of the United States Irrigation and Drainage Investigations, it was decided that it would be best to take only two samples from each plat, instead of three as last year. Instead of taking the average of each foot, it was also thought best to take the whole sample raised by the soil auger between the depths of 6 and 9 inches, and the second sample between the depths of 18 and 21 inches. As the third foot of the sample was by far the most difficult to get, reducing the depth at which the samples were taken made it possible to take as many samples as in 1906. Seventy-two are being taken each week, except when weather conditions prevent. These series for 1907 cover the whole number of experimental plats, wind-mill irrigated, dry farmed each year, dry farmed and summer fallowed alternate years, and winter irrigated, as well as two sets from sod ground, one in the natural condition and the other from the winter irrigated plat. It is thought that this full series of samples will give more definite information in hand than a fewer number of samples taken to a greater depth. As the plan of the farm was changed this year, it was not possible to continue taking the samples on the same plats from which they were taken last year, but in many ways the plats correspond and the results from year to year will be strictly comparable.

PLANS FOR THE YEAR 1907-08.

I. To keep accurate weir records both by register and note-book of the duty of water used on the experiment plats at the Station Farm.

II. To begin experiments with one-half-acre plats on the relative cost and value of three general methods of applying water to the soil. Plats sown to brewing barley are laid out to be irrigated by the flood method, the furrow method, and the check method.

III. To experiment with proper duty of water for maximum crop of brewing barley.

IV. To continue taking soil moisture samples at the Cheyenne Irrigation Extension Farm, and to have them taken at the similar farm at Newcastle. The object of these experiments to discover the underlying principles governing the action of soil moisture on land irrigated from small reservoirs, dry-farmed and winter irrigated crops, as well as on uncultivated range. This experiment is in co-operation with the United States Irrigation and Drainage Investigations and the Chemistry Department of the University of Wyoming.

V. To make soil moisture determinations on six plats of irrigated barley at the Experiment Farm at Laramie.

VI. To investigate the effect of the time of irrigation at various periods in the growth of barleys, and the effect on their yield and quality.

VII. To continue the record of the depth of seepage water on the stock farm, and if the money should be appropriated for this purpose, to carry out plans for the drainage of at least part of this farm.

VIII. If the necessary money is appropriated, to install a pumping plant and small reservoir at the University for the purpose of irrigating the campus.

IX. Attending to such other duties as teaching and Farmers' Institute work that may become necessary.

Report of the Animal Husbandman.

G. E. MORTON.

As the present Animal Husbandman severs his connection with the Station during the present fiscal year, this report will take the form of a summary of work done during the three years of his connection with the Station.

HORSE WORK.

The Station in the fall of 1904 owned two Oldenburg Coach stallions and one three-quarter-bred German Coach mare. The purpose was to attempt to develop a general-purpose type of horse for use in the State. The Station not having means to procure good breeding stock or facilities to care for them if procured, the horse breeding work was discontinued and the stallions sold as soon as possible.

In 1906 a team of typical grade Percheron mares was bought for the Station. The mares are now five and six years of age and weigh 3,725 pounds in the harness.

CATTLE WORK.

In 1904 the Station owned two Shorthorn cows and two Polled Hereford cattle, a bull and a heifer. Experimental work was being carried on with the Polled Herefords, the object being to assist in the development of the new Polled Hereford breed. The two individuals owned by the Station were pure-bred Herefords by a registered bull, and from cows owned by Mr. Warren Gammon of Des Moines, Iowa. These animals owned by Mr. Gammon were original sports, in that they were the progeny of horned cattle, but were born without horns. The development of the hornless character in Hereford cattle will undoubtedly prove of benefit to the range cattlemen of Wyoming, since the Herefords dominate the

range in the State, and dehorning steers costs the cattle growers a considerable sum annually. Therefore, the Polled Hereford breeding has been continued and developed. Additional Hereford cows (horned) were bought, bred to a Polled bull. The first crop of calves were secured in 1905, a majority of the calves developing horns. Two of the calves were polled; one, a heifer out of Polled Lora and sired by Polled Admiral, is a perfectly polled animal; the other, a bull from a horned cow and sired by Giant, developed only scurs, and is now at the head of the Hereford herd owned by the Station. Polled Admiral died in December, 1905, and Mutation 2d, another polled bull, was bought to take his place. In the fall of 1906 Mutation 2d was leased to Carey Bros. of Careyhurst, Wyoming, for use upon their herd of pure-bred Hereford cows, the Station to receive one-fourth of the calves.

The cattle breeding has been hampered greatly because of inadequate fences surrounding the pastures. In 1904 several cows were served by stray bulls, and one of these aborted her calf. Other abortions followed in rapid succession, and it gradually became evident that contagious abortion had been introduced into the herd by one of these stray bulls. The disease cost us a large part of our calf crop in 1905, although disinfection was done thoroughly and every effort was made to stamp out the disease. It was found impossible to get with calf a number of cows that aborted, even though an impregnator was used in some instances; so the calf crop of 1906 was small. In 1906 again several cows were bred by stray bulls, it being impossible to keep them out of the field where the cows grazed. Abortions again occurred, and as the only solution to the problem, it was decided to sell off all cows of breeding age, retaining only unbred heifers, and keeping these in a barn and in a pasture where the abortion had never occurred. Most of the cows have been disposed of at this date, only one or two remaining, and these should be sold soon. Then, by keeping the young stock carefully away from infec-

tion, and running them in a clean pasture inclosed by woven wire, it may be possible to prevent the recurrence of the disease. Poor fences have cost the Station hundreds of dollars in the last three years, and fencing of the stock farm should be completed as rapidly as possible.

SHEEP WORK.

Sheep work was inaugurated by the purchase of several Rambouillets in the fall of 1904. The flock was later thinned down by the selling off of the poorest of the Rambouillets, a nucleus of first-class individuals being retained. In 1905 some Shropshire and some Oxford ewes were purchased; and in 1906 breeding stock of the following breeds were added: Southdown, Hampshire, Lincoln, Leicester, Cotswold, Wensleydale, Romney Marsh, Black-Face Highland, Cheviot, Dorset, and Tunis. A pair of Persian Fat-Rump sheep were presented to the Station by the Colorado Agricultural College. Wyoming is surpassed only by Montana in the amount of wool produced, and her sheep and wool industry is one of the most important industries in the State. Therefore, it was believed that the sheep work in the Station should be a leading line of work. The large number of breeds named were secured for purposes of experiment in cross-breeding and wool scouring, and for purposes of demonstration. Good breeding flocks of these breeds gives this Station an equipment of stock for sheep and wool work which is probably not equaled by that of any other Experiment Station.

Lamb Feeding Experiments.—Feeding experiments with range lambs have been carried on each winter, the results being published in Bulletins Nos. 68, 73, and a forthcoming bulletin.

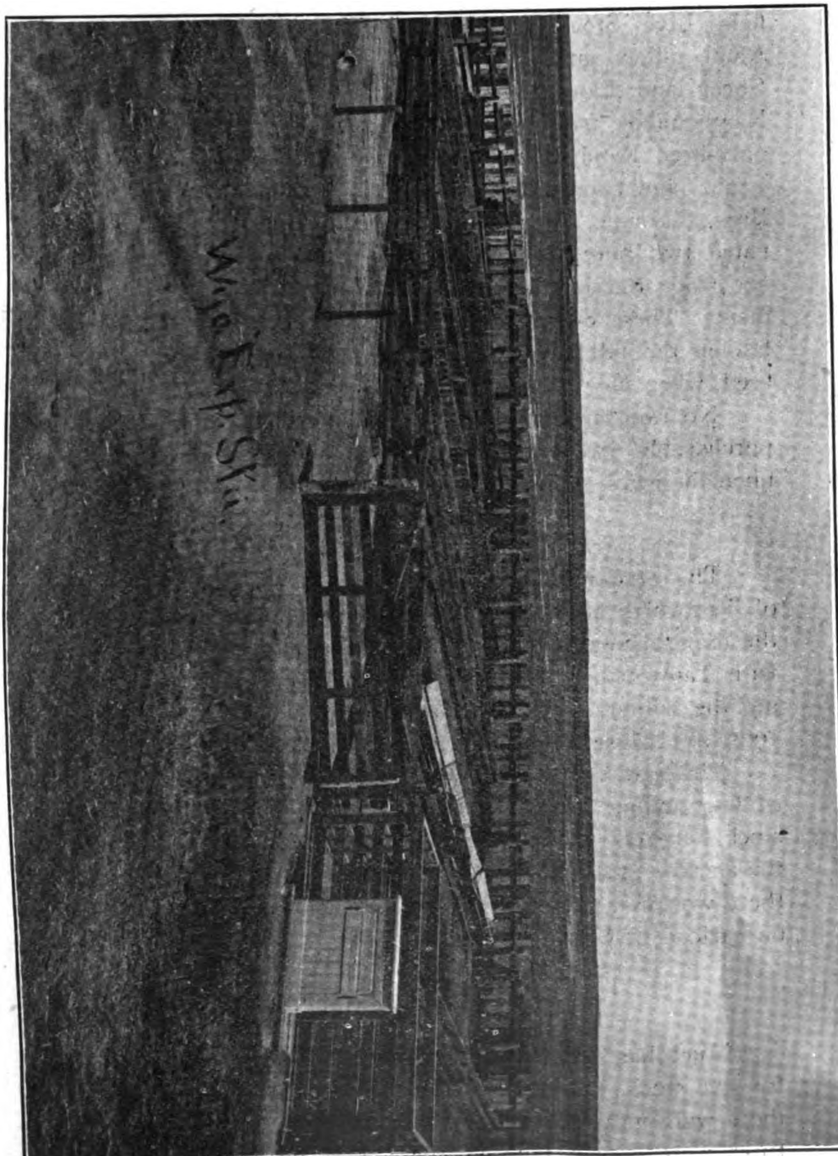
Lambing Data.—Records have been kept of the birth weights of lambs and the weights of their dams, also of the weekly gains made by lambs. Some records of weights of fleeces have been made.

Wool Scouring Work.—During the past year a three-bowl wool scouring machine has been installed upon the University stock farm. The purpose of the wool scouring is two-fold. Few of the wool growers of the State have an accurate knowledge of the shrinkage of their clips and the Station aims to give them definite information concerning it each year before they sell their clips. It is also intended to take up certain lines of research with regard to the effect of alkali, different feeds, and cross-breeding upon the wool.

The Range Sheep Breeding Experiment in Co-operation With the Office of Animal Husbandry, United States Department of Agriculture.—Probably the most important sheep work entered upon is the range breeding experiment. The experiment is in charge of the Department of Agriculture and the Animal Husbandman of this Station. The object of this experiment is the development of a type of sheep which shall be hardy upon the range, shall shear a heavy fleece of wool, be of fair size, and shall have good mutton form. It was agreed by those conducting the experiment that the foundation stock should be of large bodied, fine wool type, the reason for such decision being that fine wool sheep predominate over the entire range country and are, in fact, the foundation of the range sheep industry, and that at the same time they are deficient in size and in mutton form when compared with some other types of sheep run upon the range, and many sheepmen who run the fine wools therefor have recourse to rams of the mutton type to provide lambs for market.

Mr. G. Arthur Bell, Assistant Animal Husbandman, United States Department of Agriculture, accompanied by the author of this report, searched the northwestern and western portion of the range country for range ewes of the type desired, securing 67 head, as follows:

Seven pure-bred Rambouillets from Forbes Bros., Sheridan, Wyo.; seven grade Rambouillets from H. F. Troub, Winona, Wash.; eight grade Rambouillets from the Butter-



LAMB FEEDING PENS, WYOMING EXPERIMENT STATION, 1907.

field Live Stock Company, Weiser, Idaho; seven grade Rambouillets and four grade Delaines from the Baldwin Sheep and Land Company, Hay Creek, Ore.; six grade Rambouillets from Charles A. Kimble, Hanford, Cal.; six pure-bred Rambouillets from John H. Seeley, Mt. Pleasant, Utah; and twenty-five grade Rambouillets from F. S. King Bros., Laramie, Wyo. In addition to these, Forbes Bros. donated two pure-bred Rambouillets and King Bros. donated six grade Rambouillets to the Station for use in this experiment. These ewes arrived at the Experiment Station farm late in the fall (1906) and were kept upon the farm until bred, when they were turned upon the range.

No ram suitable for the experiment having been found purchasable, two rams were leased of King Bros. and used upon the ewes.

SWINE WORK.

The Station was equipped in 1904 with good specimens of Tamworth hogs. In 1905 Berkshires were added. All of the experimental feeding work of the Station has been done with Tamworths. Experimental feeding was carried on during the winters of 1904-05 and 1906-07, but was omitted in 1905-06 because of insufficient help to care for the stock.

The Station has been active in introducing the bacon type of hog among ranchmen, and has furnished much breeding stock. In 1906 a number of Tamworth shoats were fitted for the Denver Stock Show held in January, 1907, and the Station there won first prize on pen of barrows, bacon type, and first on carload of bacon hogs.

DEVELOPMENT OF STOCK FARM.

Much has been done in the development of the farm used for live stock, known as the old penitentiary farm. In 1904 there were no pastures for sheep or swine and the cattle pastures were poorly fenced; there were no corrals or feeding

yards on the place, and no buildings fitted for either sheep or swine. A large poultry house has been converted into a hog house, and a former broom factory temporarily fitted for sheep. Good lamb feeding yards and cattle corrals have been erected, hog pastures and sheep pastures have been enclosed with woven wire, and an eighty-acre cattle pasture is now being fenced with woven wire. Running water has been piped to the hog barn and to the lamb and cattle corrals, and movable hog houses have been built for each of the hog pastures.

WEIGHTS AND GAINS OF TAMWORTH PIGS.

Sow pigged November 15, 1904. Sow weighed after pigging.

	Sow No. 171		1, boar		2, sow		3, boar		4, sow		5, sow		6, sow		7, sow		8, sow		9, boar		10, sow		11, sow		Litter	
	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain
Beginning	349	. .	3.5	. . .	2.8	. . .	2.8	. . .	3 5	. . .	3.0	. . .	3.3	. . .	3.3	. . .	3.3	. . .	2.8	. . .	3.0	. . .	3.3	. . .	34.6	. .
First week	323	—26	6.0	2.5	4.5	1.7	4.5	1.7	6.0	2.5	5.3	2.3	5.8	2.5	5.5	2.2	6.0	2.7	*	—2.8	5.3	2.3	5.5	2.2	54.4	19.8
Second week	313	—10	9.5	3.5	7.5	3.0	5.5	1.0	9.3	3.3	8.0	2.7	9.0	3.2	8.0	2.5	8.3	2.3	. . .	. . .	6.3	1.0	8.8	3.3	80.2	25.8
Third week	310	—3	12.8	3.3	9.8	2.3	6.5	1.0	12.8	3.5	11.5	3.5	12.8	3.8	10.8	2.8	11.0	2.7	. . .	. . .	7.8	1.5	12.5	3.7	108.3	28.1
Fourth week	296	—14	15.5	2.7	12.0	2.2	7.8	1.3	13.0	.2	11.8	.3	15.5	2.7	12.5	1.7	15.5	4.5	. . .	. . .	12.5	4.7	15.8	3.3	127.9	19.6
Fifth week	293	—3	18.0	2.5	13.5	1.5	9.0	1.2	14.5	1.5	14.5	2.7	16.3	.8	14.5	2.0	16.0	.5	. . .	. . .	11.5	—1.0	18.5	2.7	146.3	18.4
Sixth week	289	—4	22.5	4.5	15.3	1.8	10.8	1.8	17.0	2.5	18.0	3.5	23.5	7.2	17.5	3.0	19.5	3.5	. . .	. . .	13.3	1.8	20.0	1.5	177.4	31.1

*Died.

WEIGHTS AND GAINS OF TAMWORTH PIGS—Continued.

Pigged Nov. 17, 1904	Sow No. 162		1, sow		2, sow		3, sow		4, sow		5, sow		6, boar		7, boar		Litter	
	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain
Beginning	370	. . .	2.5	. . .	3.0	. . .	3.8	. . .	3.0	. . .	2.8	. . .	3.5	. . .	.5	dead	19.1	. . .
First week	358	—12	4.5	2.0	5.0	2.0	5.3	1.5	5.0	2.0	6.0	3.2	5.0	1.5	. . .	. . .	30.8	11.7
Second week	341	—17	6.5	2.0	8.8	3.8	9.0	3.7	8.0	3.0	7.5	1.5	8.8	3.8	. . .	. . .	48.6	17.8
Third week	360	19	9.5	3.0	11.5	2.7	12.5	3.5	10.0	2.0	10.0	2.5	11.0	2.2	. . .	. . .	64.5	15.9
Fourth week	356	—4	13.3	3.8	13.3	1.8	15.0	2.5	11 0	1.0	10.3	.3	12.0	1.0	. . .	. . .	74.9	10.4
Fifth week	338	—18	13.8	.5	17.5	4.2	18.0	3.0	15 5	4.5	14.5	4.2	15.8	3.8	. . .	. . .	92.1	17.2
Sixth week	334	—4	17.8	4.0	20.3	2.8	27 0	9.0	22.3	6.8	18.0	3.5	19.3	3.5	. . .	. . .	124.7	32.6

WEIGHTS AND GAINS OF TAMWORTH PIGS—Continued.

Pigged May 13, 1905	Sow No. 171		1, sow		2, sow		3, boar		4, sow		5, sow		6. boar		7, boar		8, boar	
	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain
Beginning	412	...	2.0	...	3.6	...	1.9	...	3.0	...	3.5	...	2.4	...	3.5	...	3.3	dead
First week	387	—25	5.6	3.6	6.9	3.3	3.6	1.7	5.0	2.0	5.0	1.5	5.1	2.7	7.1	3.6	...	...
Second week	410	23	9.2	3.6	10.3	3.4	6.5	2.9	7.5	2.5	8.9	3.9	8.3	3.2	10.7	3.6	...	...
Third week	395	—15	12.5	3.3	14.3	4.0	9.4	2.8	10.9	3.4	13.3	4.4	11.8	3.5	15.2	4.5	...	...
Fourth week	393	—2	16.4	3.9	17.5	3.2	13.1	3.7	14.5	3.6	16.5	3.2	15.2	3.4	19.3	4.1	...	...
Fifth week	322	—71	19.8	3.4	22.0	4.5	16.8	3.7	18.9	4.4	19.0	2.5	19.0	3.8	23.0	3.7	...	...
Sixth week	334	12	24.0	4.2	26.5	4.5	22.0	5.2	17.0	—1.9	24.0	5.0	22.0	3.0	25.0	2.0	...	...
Seventh week	332	—2	25.0	1.0	28.5	2.0	24.0	2.0	24.0	7.0	25.0	1.0	26.3	4.3	28.0	3.0	...	...
Eighth week	331	—1	25.0	0.0	32.0	3.5	27.5	3.5	26.0	2.0	27.0	2.0	27.0	.7	30.0	2.0	...	...
Ninth week	325	—6	35.0	10.0	37.0	5.0	33.0	5.5	34.0	8.0	36.0	9.0	33.0	6.0	29.0	—1.0	...	...
Tenth week	315	—10	31.0	4.0	38.0	1.0	37.0	4.0	35.0	1.0	36.0	0.0	36.0	3.0	35.0	6.0	...	...

WEIGHTS AND GAINS OF TAMWORTH PIGS—Continued.

Pigged May 15, 1905	Sow No. 102		1, sow		2, sow		3, sow		4, sow		5, sow		6. sow		7, boar		8, boar	
	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain
Beginning	421	...	3.0	...	3.1	died	3.8	...	2.3	...	2.8	...	2.8	...	3.5	...	2.2	dead
First week	417	—4	6.3	3.3	...	...	6.9	3.1	5.0	2.7	6.1	3.3	5.8	3.0	6.1	2.6	...	...
Second week	423	6	9.8	3.5	...	...	10.8	3.9	7.5	2.5	9.0	2.9	6.5	.7	9.3	3.2	...	...
Third week	419	—4	13.0	3.2	...	...	15.0	4.2	10.5	3.0	12.0	3.0	5.0	died	13.2	3.9	...	...
Fourth week	398	—21	16.8	3.8	...	...	19.0	4.0	14.4	3.9	15.4	3.4	...	...	17.2	4.0	...	...
Fifth week	382	—16	21.5	4.7	...	...	23.0	4.0	18.3	3.9	20.0	4.6	...	...	21.0	3.8	...	...
Sixth week	345	—37	24.0	2.5	...	...	28.0	5.0	21.0	2.7	22.5	2.5	...	...	23.5	2.5	...	...
Seventh week	349	4	27.0	3.0	...	...	30.0	2.0	22.0	1.0	26.0	3.5	...	...	25.0	1.5	...	...
Eighth week	342	—7	29.0	2.0	...	...	31.0	1.0	24.0	2.0	27.0	1.0	...	...	26.0	1.0	...	...
Ninth week	346	4	36.0	7.0	...	...	40.0	9.0	34.0	10.0	30.0	3.0	...	...	35.0	9.0	...	...
Tenth week	320	—26	38.0	2.0	...	...	43.0	3.0	34.0	0.0	37.0	7.0	...	...	37.0	2.0	...	...

WEIGHTS OF EWES AND LAMBS.

Breed	Sex of lamb	Ewes, weight at lambing, lbs.	Lambs, birth weight, lbs.
Shropshire	Ram	97	7.5
"	Ram	103	10.0
Rambouillet	Ewe / Ewe	117	9.5 / 10.0
"	Ewe	147	10.5
"	Ram	148	10.5
"	Ram / Ewe	170	12.0 / 10.0
"	Ewe	167	14.0
Oxford Down	Ewe	139	10.0

WEIGHTS OF HEREFORD CALVES (BULLS).

	Polled Laramie	Mutation 2d	Giant's Hybrid	Rosebud's Hybrid	Minority Admiral
	lbs.	lbs.	lbs.	lbs.	lbs.
At birth	......	......	......	71	72
At six months	402	......	357	415	417
At nine months	580	589	465	637	677
At twelve months	......	836	......	935	900
At eighteen months	1245	......	1054	1142	......

WEIGHTS AND MEASUREMENTS OF HEREFORD HEIFERS.

LARAMIE LORA (Polled): Weight in pounds; measurements in centimeters.

	Weight	Poll to eyes	Poll to nose	Width between eyes	Diameter of muzzle	Width of poll
At birth	76	11.1	21.5	9.5	7.8	7.2
First month.	141	12.6	25.6	11	8.7	8.9
Second month. . . .	194	14	28.2	11.7	9.5	8.7
Third month	273	14.5	31.3	12.7	10	7.8
Fourth month. . . .	366	15.7	32.4	13.2	10.1	9.9
Fifth month.	419	16.2	35.3	14	10.6	10.3
Sixth month	497	16.5	36.3	14.8	11.3	11.4
Ninth month. . . .	676	17.8	39.8	15.2	12.7	13.6
Twelfth month . . .	830	19.2	42.4	17.2	12.7	14.2

LARAMIE BELLE (Horned).

	Weight	Poll to eyes	Poll to nose	Width between eyes	Diameter of muzzle	Width of poll
At birth	68	11.5	22.4	9.8	8	7.7
First month.	103	11.8	25.8	11	8.9	7.9
Second month . . .	147	14	26.5	12	9.5	8.4
Third month	206	13.6	29.8	12.3	10	10.8
Fourth month. . . .	288	15	32.2	13	10.9	12.3
Fifth month.	370	15.3	34.7	15.1	11.4	12.6
Sixth month	452	16.2	36.4	15.2	11.5	13.2
Ninth month. . . .	616	19.8	40.3	16	12.6	14.5

LANDLADY'S DAUGHTER (Horned).

	Weight	Poll to eyes	Poll to nose	Width between eyes	Diameter of muzzle	Width of poll
At birth	89	13.2	24	9.3	7.5	9.2
First month.	142	13.5	25.6	10.9	8.4	9.9
Second month . . .	233	14	29.1	12.7	10.1	11.2
Third month	282	15.1	31.6	13.5	10.8	13.7
Fourth month. . . .	380	16.4	34	13.1	11.1	13
Fifth month.	432	17	35.4	14.8	12.5	14.5
Sixth month	510	17	37.5	14.5	11.9	12.5

Report of the Agronomist.

R. E. HYSLOP.

My work with this Station began on the first of July of this year, and my connections with the Station were severed on June first of the same fiscal year.

When I arrived here I found most of the grain in a very backward condition, due probably to adverse conditions, which prevented early sowing.

The following experiments were being carried out:

I. Barley variety tests.
II. Pea variety tests.
III. Effect of intercultural tillage upon the yield of wheat and oats on a worn out plat.
IV. Effect of amount of pease sown, per acre, upon the yield.

The following was begun in July:

INFLUENCE OF NITRATE UPON THE YIELD OF BARLEY—BARLEY VARIETY TEST, 1906.

The barley variety test consisted of 308 varieties, 260 of which were furnished direct from the United States Department of Agriculture. The others had been grown on the Station farm. As these barleys were grown on two different plats, and as no checks were used, the yield of those on one plat cannot be compared with those on the other. On one plat (8) the rows were 98 feet in length; on the other (30) 198 feet. The majority of these varieties, however, did not occupy full rows. As it was thought that this might influence the results, the length of row from which the yield is computed is given in the results in each case. The rows were practically 16 inches apart. The results of this test follow:

REPORT ON CO-OPERATIVE INVESTIGATIONS OF CEREALS BY THE WYOMING AGRICULTURAL EXPERIMENT STATION AND THE BUREAU OF PLANT INDUSTRY, U. S. DEPARTMENT OF AGRICULTURE, FOR THE YEAR 1906.

STATION VARIETIES	C. I. No.	Height, inches	Length of head	Average time of ripening	Grain in pounds per 198-ft. row	Remarks
Kilina	13	30	4	9-5	10	Computed from 98-ft. row
Frick	20		4		11.5	
Scotch Annat	14	31	3	9-13	10	
New Black	50	32	2.5	9-4	9.5	
Black Grain	35	26	2.5	9-4	7	
"27"	27	26	3	9-13	5.5	
Animate	17	36	4	9-24	7.75	
Battledore	42	36	4	9-14	11	
Winnipeg	2	36		9-13	9	
Hull-less Tibet	000	29	2	9-4	11.75	
Carter's Prize	47	35	3	9-14	10.25	
Wales	31	35	3	9-14	9	
Indian	12	36	2	9-24	8.25	
Sibley's	26	37	3	9-24	5	Injured by birds
Sibley's Purple	30	36	4	9-24	9.75	
	18	25	3	9-5	7	
Nepaul	23	32	2	9-14	6.5	
Winnipeg	1	34	3	9-24	8	
	43	32	3	9-24	10	
	44	28	2	9-5	11	
	45	26		9-6	9.75	
	83	33		9-6	8	
Sibley's Pearl	21	33	4	9-25	8.75	
	48	38	4	9-25	11.75	
	49		4		8.75	
Del Norte	10	28	3	9-6	9.75	
Himalaya	46	26	2.5	9-6	7.25	
Manchuria	19	36	3	9-25	10.5	
Spring	21	35	3	9-24	11	
Purple	8	38	3	9-25	8.75	
	37	37	3	9-25	10	
Winter	24	30	4	9-25	9	
Zeocrit	33	36	3	9-25	5.25	
	31	38		9-15	12	
J. A. Fisher	59	36	3.5	9-25	6.5	
New Highland	20	35	4	9-23	11	
Zeland	6	34	3	9-25	5.75	
	62	34	4	9-28	11.5	
Palestine	16	33	4	9-28	5	
Algerian	40		3.5		5.5	
	39	39	3	9-14	7	
	34	32		9-26	10	
Black	15	30	3	9-14	3.75	
Hull-less	68-1	27	2	9-7	7	
Phoenix	25	27	3	9-14	4.75	
Guymalye	36	25	3	9-7	11	
Guymalye	18	25	3	9-14	13	
Hull-less	85	24	4	9-7	9.75	

REPORT ON CO-OPERATIVE INVESTIGATIONS OF CEREALS BY THE WYOMING AGRICULTURAL EXPERIMENT STATION AND THE BUREAU OF PLANT INDUSTRY, U. S. DEPARTMENT OF AGRICULTURE, FOR THE YEAR 1906.

PLAT 8.

NAME OF VARIETY	C. I. No.	Height, inches	Length of head	Average time of ripening	Grain in pounds per 98-ft. row	Remarks
	401	33	2	9-12	8	Yield in pounds per 98-ft. rows, 18 inches apart
	497	23	3	8-29	11.5	
Golden Melon	415	38	4.5	9-12	5	
	499	23	2	8-26	12.5	
Fodder Barley	395	38	4	9-12	9.75	
	508	25	2	8-29	9.5	
	378	35	2	8-29	11	
Hull-less	493	24	3	8-29	15	
Hull-less	421				0	
Hull-less	475	33	3	8-30	?	
Brasserie	385	34	4.5	9-12	13	Computed from 54-ft. row
	496	20	3	9-3	13	
	501	20	2	9-3	11	
	11042	30	2.5	8-28	13	Computed from 18-ft. row
Alaska	534	39	3	8-29	6.6	Computed from 84-ft. row
	500	27	3	9-7	13	
	268818					No good
Bald Hull-less	489	35	3	8-29	8	
	466	32	2.5	8-30	18	Computed from 49-ft. row
	468	36	3	9-3	10.5	Computed from 53-ft. row
	467	34	4	8-30	18	Computed from 45-ft. row
	464	32	2.5	9-3	10	Computed from 58-ft. row
	465	27	4	9-31	12.5	Computed from 28-ft. row
	463	28	2.5	9-3	11.5	Computed from 17-ft. row
	462	32	4	9-3	7.5	Computed from 53-ft. row
	470	32	3.5	9-3	11.5	
	469	34	4	9-3	8.5	Computed from 49-ft. row
Hull-less	471	36	2.5	8-29	10.5	Computed from 27-ft. row
Hull-less	474	36		8-29	0	Not thrashed
	426				0	
Hull-less	425					
Hull-less	424		4		12.5	Computed from 49-ft. row
Hull-less	419				0	
	430				0	
Hull-less	422				0	
Hull-less	423				0	
Hull-less	420	34	2.5	9-12	10	Computed from 52-ft. row
	428				0	
Heines Chevalier	417	36		9-27	0	Not worth thrashing
	495	21	4	8-28	5.5	
	505	20	2.5	8-28	11	
	508 / 781	34		8-30	11	
	509 / 1102	38	3.5	8-31	11.5	
	427				0	
Four-rowed	413	32	3	8-28	11	
	268794 / 523	37		9-12	0	Not worth thrashing

REPORT ON CO-OPERATIVE INVESTIGATIONS OF CEREALS—Continued

PLAT 8—Continued.

NAME OF VARIETY	C. I. No.	Height, inches	Length of head	Average time of ripening	Grain in pounds per 98-ft. row	Remarks
	511	32		8–28	11.75	
	510	31		8–28	15.5	
	504	21	3	8–28	10.75	
	502	18	[illegible]	8–28	?	
	498	18		8–28	4.5	Ripened unevenly
	494	16	1.5	8–21	15.75	
White Hull-less	479	30	2	8–28	7	Computed from 44-ft. row
White Winter	488	38	2	9–12	9	Computed from 52-ft. row
Mammoth Winter	410				0	
Hull-less	477	31	1.5	9–11	11	Computed from 39-ft. row
Large Grained Winter	408	32	3	9–27	1	
Hull-less	487	33	3	9–3	9.5	Computed from 15-ft. row
Winter Barley	486	36	3	9–7	9	Computed from 11-ft. row
Winter Barley	485	34	3.5	9–7	?	
Black	404	34	2.5	9–3	16	Computed from 12-ft. row
Beardless	473	40	2	8–28	11	Computed from 8½-ft. row
	403	36	4	8–28	18.5	Computed from 26½-ft. row
Hull-less	472	33	2	9–3	6.5	Computed from 15-ft. row
	402				0	
Hull-less	477	31	3	8–29	13.5	Computed from 36-ft. row
Bestchorn's Giant Winter	414	40	3.5	9–7	14.5	Computed from 43-ft. row
	461	29		8–21	8	Computed from 49-ft. row
Brasserie	380	39	2	9–7	20	Computed from 44-ft. row
	399			9–7	13.5	Computed from 44-ft. row
Brasserie	394	39	2.5	9–7	10.5	Computed from 50-ft. row
	372	30		8–28	8.5	Computed from 49-ft. row
	368	39	4	9–7	15.5	Computed from 40-ft. row
	393	38	4	9–7	9.5	Computed from 40-ft. row
Azov	373				9.75	
	370	39	2.5	9–27	7	
Chevalier	376	41	4	9–8	9	
	365	34	4	9–8	12	
	364	35	4	9–12	9	Computed from 41-ft. row
Brasserie	384	38	3	9–12	5	Computed from 30-ft. row
Brasserie	383	40	4	9–12	8	
	375	40	3.5	9–8	12.5	Computed from 45-ft. row
Varna	398	40	2.5	9–7	9	Computed from 51-ft. row
	433	35	2.5	9–8	5.5	
Black Hull-less	480	29	3	8–27	10	Computed from 27-ft. row
	491	31	?	8–29	12	Computed from 32-ft. row
Beardless & Hull-less	490	34	3	8–21	10	Computed from 39-ft. row
Hull-less	492				6	Computed from 33-ft. row
Black Hull-less	481	31	3	8–29	12	Computed from 35-ft. row
	431				0	
Himalaya	483	28	2.5	8–29	9	Computed from 35-ft. row
Nepal Hull-less	482	33	4	8–29	8.5	Computed from 29-ft. row
Ideal Hull-less	484	35	3	8–29	12	Computed from 32-ft. row
	459	30	3	8–29	11.5	Computed from 36-ft. row
	458	31		9–8	2.5	Computed from 29-ft. row
	456	33	3	9–8	4.5	Computed from 32-ft. row
	457	31	4	9–8	2	Computed from 34-ft. row
	429				0	

REPORT ON CO-OPERATIVE INVESTIGATIONS OF CEREALS—Continued

PLAT 8—Continued.

NAME OF VARIETY	C. I. No.	Height, inches	Length of head	Average time of ripening	Grain in pounds per 98-ft. row	Remarks
Canada	455	31	2.5	9-8	19.5	Computed from 29-ft. row
	460	34		9-8	0	
Hull-less	454				0	
	488				4.75	
Nepaul	210	30	4	9-8	12	Computed from 29-ft. row
Frankish	295	36	3	9-12	14.5	Computed from 31-ft. row
Laniger	274	36	3.5	9-12	6.5	Computed from 26-ft. row
Telli	194	36	3	9-27	7.5	
Beldi	190	24	2	8-30	9.5	
Bohemian	284	35	3	9-12	7.5	Computed from 28-ft. row
Orgebela	356	34	3	8-30	8	Computed from 32-ft. row
"No. 683"	308	36	2.75	9-12	26.9	Computed from 31-ft. row
Bohemian	310	31	3	8-30	10	
Kwassitzer	275	37	4	9-8	7.9	Computed from 21-ft. row
Bohemian	293	34	3	9-12	7.5	Computed from 64-ft. row
Six-rowed	262	31	2.75	8-28	9.75	
Hanna	318	37	3	9-8	10.5	Computed from 44-ft. row
Middle Barley	297	36	?	9-12	10.5	Computed from 50-ft. row
Frankish	294	37	3	9-8	13	Computed from 40-ft. row
Lower Bavarian	296	33	4	9-12	8.5	Computed from 58-ft. row
Laning	302	33	4	9-8	12	Computed from 49-ft. row
Jewel	300	36	3	9-12	10.5	
"Arpa"	528	33	?	8-31	8.5	Computed from 53-ft. row
	526	32	2.5	9-8	13	
Yenidje	205	31	4	8-27	12.5	
Palras	168	30	2	9-8	10	
Trifurcate	334	33	3.5	9-8	5.5	
Bohemian	345	33	4	9-8	7.5	
Celeste Hull-less	260	36	3.5	9-8	5.5	
Manchuria	237	38	4	8-28	8.5	
Moravia	343	31	4	8-30	10	
Rennies Improved	181	34	3.5	8-28	9.5	
Nepean	188	40	4	8-28	6.5	
Lower Bavaria	236	31	4	8-30	10	
Bise or Facher	341		?		8.25	
Bohemian	270	32	4	8-31	10	
"No. 2"	313	34		9-8		
Bestehorn	331	30	4	9-8	8.5	
Gambrinus	330	35	3.5	9-12	8.5	
Large Two-rowed Hull-less	333	28	3.5	8-31	7.25	Lodged
Victoria	323	34	3	9-8	11.5	
Brasserie	340	32	4	9-27	6	
Nepal	321	36	3	9-8	9.25	
White Smyrna	195	25	2.5	9-8	11.5	
Hanna	203	31	4	8-31	15.5	
Read's New Barley	513	33	3	9-8	3.75	
Kitzing	167	38	4	9-8	11.5	
Perm	20		3		8	
Manchuria	235	36	4	8-21	7	
Phoenix Von Chielan	325	33	4	9-8	8.5	
Himalaya	322	29	3.5	9-8	9	
Kitzing	189	32	3	9-8	9	

REPORT ON CO-OPERATIVE INVESTIGATIONS OF CEREALS—Continued

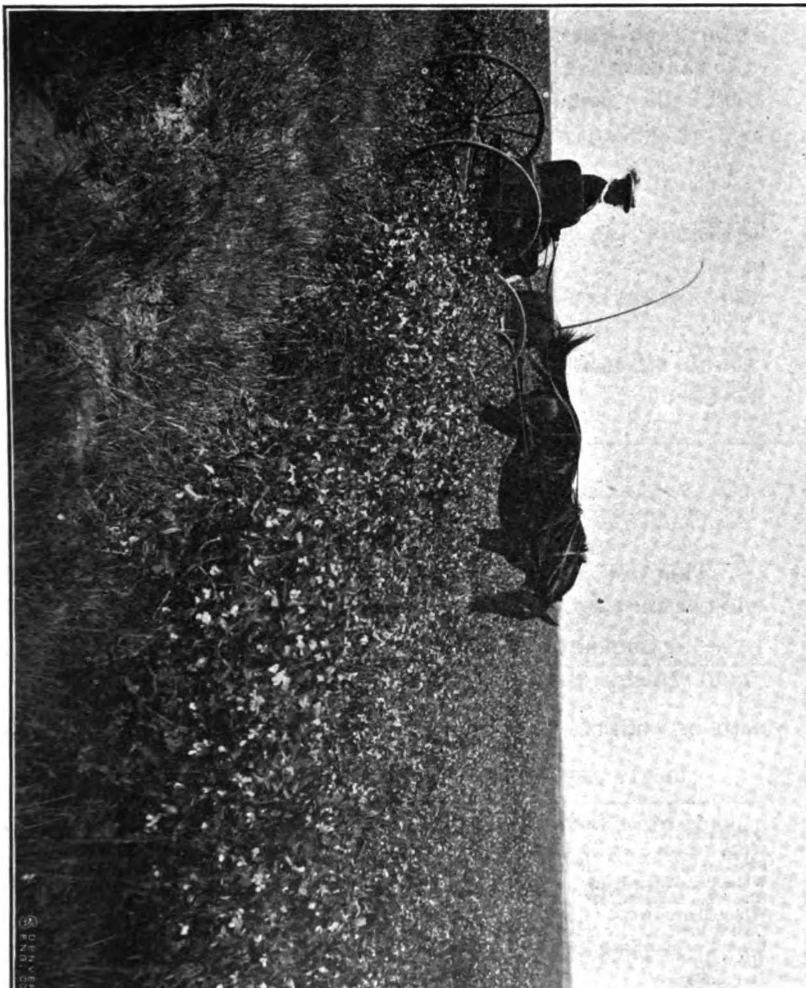
PLAT 8—Continued.

NAME OF VARIETY	C. I. No.	Height, inches	Length of head	Average time of ripening	Grain in pounds per 98-ft. row	Remarks
	307	34	3	9-8	8.25	
	192	34	4	9-8	9.75	S. P. I. D. No. 6601
Trooper	178	36	3.5	8-30	6.25	
Colassal	234		3.5		5.75	
Bavarian	206	34	3	9-8	8.5	
Bohemia	188	33	4	9-8	8.5	
Bohemia	285	34	4	9-10	8.75	
Bolton	177		3		7	
Bavarian	159	37	3	9-10	8.25	
	362	28	3	8-27	4.5	Computed from 51-ft. row
	361-1	29	3	8-27	4.5	Computed from 50-ft. row
	360	32	2	8-27	7.5	Computed from 56-ft. row
Black Barley	359	26	2.5	8-27	6.5	Computed from 42-ft. row
Common Two-rowed	288	34	4	9-10	9.75	
Perm	17	35	4	9-10	9.25	
Tetcherit	196	27	3	9-10	9	
Black	256	25	3	9-10	9.75	
Black Arabian	202	34	4	9-24	6.5	
Common	212-2	28	3	9-10	12.75	
Summit	174	32	4	8-27	8.5	
Bavarian	228		2.5		9.5	
Beardless	238	32		8-27	7.5	
Kitzing	272	35	3	9-10	8.5	
Funfstittner	279	35	3.5	9-10	10.25	
Early Russian	233	34	2.5	9-27	8.5	
	265	35	3	9-10	8.5	S. P. I. D. No. 10362
Frankish	304	35	3.5	9-11	12	Computed from 49-ft. row
Tauber	308		3.5		8	Computed from 75-ft. row
Schwarzenberg	347	34	4	9-11	9.75	Computed from 45-ft. row
Chevalier	290		3		9	Computed from 53-ft. row
Gold Foil	162	35	4	9-11	10	
Ideal Hull-less	230	29	2	8-30	7	
Common	184		2.5		8.5	
Grecian Six-rowed	336	36	3	9-11	8	
Webs	268	39	4	9-11	8.75	
	19495	24	1.75	8-27	5.75	
Kitzing	201	35	4	9-11	13.25	
Bohemian	344	31	4	9-11	11.5	Computed from 52-ft. row
	527	31	3	9-11	9	Computed from 45-ft. row
	263	34	3	9-11	9.5	S. P. I. D. No. 10360
	231	33	2	8-27	4.5	
Sidney	178	35	4	9-11	6.5	
White Hull-less	239	32		8-30	8.25	
Ohio Beardless	231	40		8-30	5	
Early Russian	238	32	2	8-27		
Six-rowed	90	30	2.5	8-30	7.25	
Frankish	282	32	3	9-11	15.5	
Albacete	130	30	2.5	9-11	8.5	

REPORT ON CO-OPERATIVE INVESTIGATIONS OF CEREALS BY THE WYOMING AGRICULTURAL EXPERIMENT STATION AND THE BUREAU OF PLANT INDUSTRY, U. S. DEPARTMENT OF AGRICULTURE, FOR THE YEAR 1906.

PLAT 30.

NAME OF VARIETY	C. I. No.	Height, inches	Length of head	Average time of ripening	Grain in pounds per 198-ft. row	Remarks
Victor	179	29	3	9-3	12	
Scottish Pearl	277	32		9-12	10	
Bohemia	204	31		9-12	11	
Success	212-1	30	2	8-31	9.5	
White Hull-less	229	29		8-31	10	
	264	33	3	9-12	4	S. P. I. D. No. 10361
Princess	193	30	2.75	9-12	17.5	
Schwarzenberg 3d	348	29	4	9-12	9.5	
Bavarian	158	29	4	9-3	21.5	
Manchuria	240	30	3	8-31	7.5	
Franken	269	30	3.5	8-31	8.5	
Swan Neck	187	31	3	8-31		
Little Blue Hull-less	335	28	3	9-3	10	
Chevalier	156	31	2	9-12	4	
Sholey's Chevalier	339	24	4	9-3	14	
Two-rowed Hull-less	253	29	4	9-3	8	
Gold Medal	271	29	2.75	9-3	8	
Manchuria	329	31	3	9-4	11.5	
Hanna	287	29	4	9-3	8.5	
Surprise	171	30	4	9-4		
Black Smyrna	191	23	4	9-3	14	
Manchuria	170	30		8-29	8	
Bavarian	160	32	4	9-12	16	
Two-rowed	214	31	2.5	9-4	.5	
Highland Chief	209	34	4	9-12	12.5	
Olonesk	198	30	4	9-4	7	
Six-rowed	218	30	4	9-4	6.5	
Kimulaya Hull-less	254	27	4	9-3	10	
Sisolsk	89	31	2	9-4	7	
	311	32	4	9-12	4.5	
Chevalier	278	30	4	9-5	11.5	
	312	30	4	9-4	7	
Jewel	324	30	2.5	9-5	1.75	
Jewel	299	?	4	9-12	9.5	Not pure
Funstettener	280	32	3.5	9-12	9	
Chevalier	291	33	3	9-13	9	
Crimean Hull-less	320	34	4	9-13	12	
Lower Frankist	207	34	3	9-13	10	
Pilsen	273	31	2.5	9-13	11	
Black Barley	357	26	4	9-5	8.5	
Christensen's Goldthorpe	298	32	2	9-13	10	
Hanna	305	32	3	9-13	4	
Kitzing	316	31	3	9-13	13.5	
Altamura	91		2			
Country Barley	276	30	4	9-13		
Chevalier	267	32	3	9-13	12	



FIELD PEAS, WYOMING EXPERIMENT STATION FARM, 1906.

REPORT ON CO-OPERATIVE INVESTIGATIONS OF CEREALS—Continued
PLAT 30—Continued.

NAME OF VARIETY	C. I. No.	Height, inches	Length of head	Average time of ripening	Grain in pounds per 198-ft. row	Remarks
	261-2	29	2	9-5	11.25	
Chevalier II	200	23	3	9-5	14.25	
Melon	288	35	3	9-26	5	
Kaiser	281	33	3	9-13	9	
Bohemian	310	31	3	9-13	0	
	319	33		9-13	0	
Hanna	226	27	3	9-13	0	
	266	37	4	9-13	6.25	
White Hull-less	250	30	2	9-5	12.25	
Prague	317	30	3	9-5	11	
	349	30	3	9-13	?	
Imperial	289	36	2.5	9-13	9	
Chevalier Beardless	249	31	3	9-5	11.5	
Alicante	166	26	2.5	9-4	11.5	
Manchuria	244	33	3	8-28	7	
Odessa	182	30	2	8-28	7.25	

PEA VARIETY TEST.

This test consists of twelve varieties sown on practically one-twelfth-acre plats.

TABLE SHOWING RESULTS OF PEA VARIETY TEST.

NAME OF VARIETY	Average time of blossoming	Average time of ripening	Height in inches	Yield per acre Straw	Yield per acre Seed	Remarks
				lbs.	lbs.	
Scotchman	8-25	Killed by frost, 9-24	30	1992	528	Seed immature
White Canada	8-2	Killed by frost, 9-19	14	1608	912	Short but sturdy plant
Blue Canada	8-8	Killed by frost, 9-24	32	2712	648	Immature
White Pea, Laramie, '05	8-12	" "	31	1440	660	Seed fairly hard
Blue Pea, Laramie, '05	8-14	" "	34	2688	552	" " "
White Marrowfat	8-15	" "	32	1764	556	" " "
Golden Rine	8-8	" "	30	1668	532	" " "
Black Eye Marrowfat	8-8	" "	31	1740	444	Immature
Mexican	8-10	" "	36	*	*	"
Station Variety	8-14	" "	32	*	*	"
Station Variety	8-12	" "	32	*	*	"
Station Variety	8-12	" "	30	*	*	"

*Not thrashed.

EFFECT OF INTERCULTURAL TILLAGE UPON THE YIELD OF OATS AND WHEAT ON A PLAT WORN OUT BY CONTINUOUS CROPPING.

The acre plat upon which the experiment was performed was divided into four divisions. Upon one division Durum wheat was drilled in with the ordinary press shoe drill. The next quarter was sown to the same crop, but in drilling in this division of the plat the alternate drill holes were stopped up, leaving 16 inches between each row of the grain. The other half of the plat was sown to oats in the same way in which the wheat was planted.

The oats and wheat both showed signs of starvation upon the first division of the plat, but that which was cultivated maintained a darker color throughout the season. An unfortunate mistake in the cutting made it impossible to obtain the yields of the separate plats of wheat.

RESULTS OF EXPERIMENTS.

	Height	In full head	Yield per acre	
			Straw	Grain
Wheat—Cultivated	28	8-4	812	15 bu.
Oats—Uncultivated	22	8-5	812	14.6 bu.
Cultivated	34	7-23	1240	8.16 bu
Wheat—Uncultivated	32	7-25		

The cultivated oats were of a little better quality than those which received no cultivation.

EFFECT OF AMOUNT OF SEED SOWN UPON THE YIELD.

In this experiment different amounts of seed were sown, in order to determine the effect upon the yield. One acre of land was divided into four parts. After the pease were well started a frame one yard square was made and then thrown in different parts of each plat. The number of plants within the frame were then counted. The average of these different determinations was considered to be the average number of plants per square yard upon an acre. The number of plants per acre was computed. The result of the test was as follows:

Plat No.	No. of plants per acre	Yield per acre	
		Straw, lbs.	Seed, lbs.
Plat 1	135,520	3,940	560
Plat 2	96,800	2,158	282
Plat 3	164,560	4,536.4	343.6
Plat 4	193,600	5,794	606

THE EFFECT OF NITRATE UPON HULL-LESS BARLEY.

Sodium nitrate was applied upon one-quarter of the plat of Hull-less barley. At the time of applying the fertilizer, July 7th, the grain was several inches high. The plat was irrigated immediately after the application of sodium nitrate. At the end of two weeks the effect of the fertilizer could be seen at some distance from the plat, that which had been fertilized showing much darker in color. The first plat was medium fertile.

RESULTS.

	Yield per acre	
	Straw, lbs.	Grain, bu.
Hull-less Barley { Fertilized	5,649.9	44.3*
Hull-less Barley { Unfertilized	2,024	23.9
Increase of fertilized grain	3,625.9	20.4

*Sixty pounds per bushel.

The increase in weight of straw is largely due to volunteer oats.

PLANS OF THE AGRONOMIST, 1907-08.

I. Continuation of barley variety tests.
II. Continuation of wheat variety tests.
III. Continuation of oats variety tests.
IV. Continuation of pea variety tests.
V. Continuation of potato variety tests.
VI. Intercultural tillage.
VII. Effect of manure upon obtaining a stand of grass in alkali soils.
VIII. Breeding work.
IX. Early and late sowing.

VARIETY TESTS.

The general plan in these variety tests is to find those varieties which mature early and give satisfactory yields. Then to increase the seed from these varieties as soon as possible, so as to be able to send it out into different parts of the State to be introduced to the farmers. At this altitude (7,200 feet) the great need of the farmers is good early maturing varieties.

BARLEY VARIETY TESTS.

The barley variety test being carried on this year is but a continuation of last year's test, the better varieties of last year being used this year on a larger scale. The better varieties which produced sufficient seed last fall to permit harvesting were sown in one-tenth-acre plats. Eighteen varieties are being tested out in this way. Those smaller varieties which showed sufficient merit to be replanted were sown in one-twentieth-acre plats. With these varieties are also sown a few obtained direct from the United States Department of Agriculture this year. A half acre is given over to the retesting of some of the Hull-less varieties, the amount of land given to each variety in this test depending upon the amount of seed available in each case. There are in all 54 varieties being tested, 17 of which are Hull-less.

WHEAT VARIETY TEST.

The wheat variety test consists of but four varieties sown on three-twentieth-acre plats. These varieties are as follows:

I. Blue Stem Minnesota No. 169, from Minnesota.
II. Blue Stem Minnesota No. 169, Wyoming grown.
III. Fife, Wyoming grown.
IV. Durum, Wyoming grown.

The Blue Stem from Minnesota was obtained directly from the Minnesota Experiment Station, this year.

The Wyoming-grown Blue Stem and the Fife were received from the farmers near Wheatland, Wyo. The Durum

was grown on the Station farm last year. The Durum is tested with these varieties to determine the advisability of raising that variety for a feed.

OATS VARIETY TEST.

This test consists of five varieties, as follows: Delmane, Kherson, Idaho, Swedish-Select, and Black Beauty oats. The Delmane and Idaho varieties were obtained from ranchmen near Laramie. The Kherson and Swedish Select were obtained from a seed company of Wheatland, Wyo. The Black Beauty oats were grown on the Station farm last year.

PEA VARIETY TEST.

This test is made up of twenty varieties, as follows:

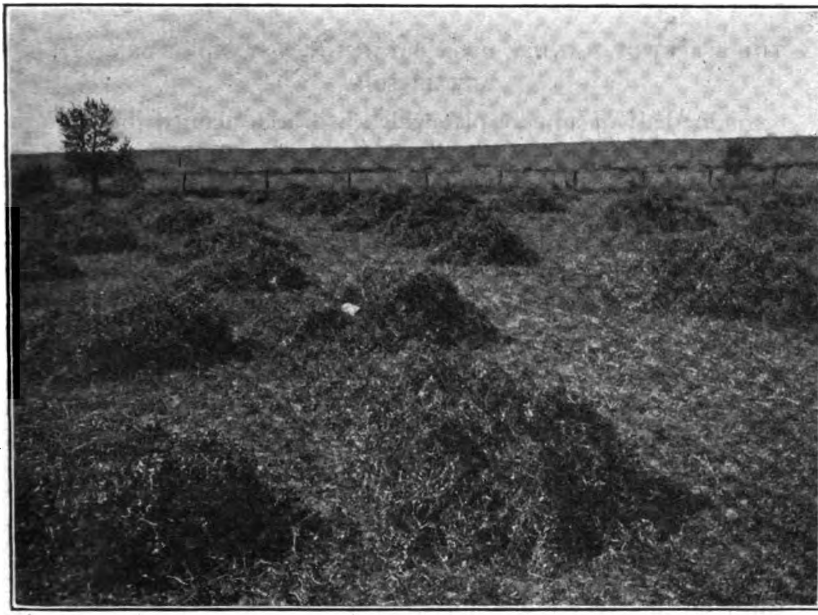
Plat 1—Pea No. 2.
Plat 2—Pea No. 19785.
Plat 3—Pea No. 19787.
Plat 4—Pea No. 19788.
Plat 5—Pea No. 19786.
Plat 6—Pea No. 16130.
Plat 7—Pea No. 7.
Part 8—Pea No. 4.
Part 9—Pea No. 6.
Part 10—Pea No. (Stickney), White Canada.
Part 11—Pea No. 19711.
Part 12—Pea No. 19290.
Part 13—Pea No. 19709.
Part 14—Pea No. 2.

The pea varieties which arrived late, Plat 21:

Part 1—No. 20465.
Part 2—No. 20466.
Part 3—No. 19787.
Part 4—No. 20467.
Part 5—No. 19710.
Part 6—No. 16130.
Part 7—No. 19389, to end of the plat.

All of these were obtained from the United States Department of Agriculture with the exception of Nos. 2, 4, 6, and 7, which were grown on the Experiment farm last year. As the last five varieties arrived late, it was found necessary to sow them on a different plat from which the others had

been planted, but as a couple of checks were used, it is hoped that the results will be comparable.



FIELD PEAS AFTER BEING PULLED AND RAKED.
Each row shows a different variety.

POTATO VARIETY TESTS.

This test consists of but four varieties, each variety being planted to one-eighth of an acre.

The following were used in the experiment: Waltmann, Viol, Phobus, and Slatum.

The first three were obtained from the United States Department of Agriculture. These were sown in rows 2½ feet apart and practically 8 inches apart in the row, and four inches deep.

EXPERIMENTS IN INTERCULTURAL TILLAGE.

This experiment is being carried out this spring in the same manner as last.

THE EFFECT OF MANURE UPON OBTAINING A STAND OF GRASS IN ALKALI SOIL.

One-half of an acre plat which had been planted the previous spring was given a medium heavy coat of manure. The other half was untreated. The manure was disced in and wheat grass sown on the entire plat.

TO PRODUCE ALFALFA SEED IN A HIGH ALTITUDE.

This is simply a trial of the different methods of growing alfalfa seed in the short season which must be contended with here.

BREEDING WORK.

Plans had been made and work had been begun along this line when it was found that the only plat where the work could be carried on was too foul to allow the work to proceed. The plat will be summer fallowed, so that there will be no difficulty next year if the new Agronomist should wish to carry on this very important work.

EARLY AND LATE SOWING.

The oats and wheat plats were each divided into three divisions. The first division of each plat was sown the first of April, which was early planting in this climate. The second division was sown two weeks later; the third one month later than the first. As the soil was very dry at the time of the first sowing, the seed remained in the ground for three weeks before germinating. The seed sown in the middle of April, because of more favorable moisture conditions, germinated in two weeks, while that sown in the latter part of the month began to germinate before it had been in the soil two weeks. At this writing (June 1st) the difference in appearance is not so marked as it was a week ago.

Meteorological Report

BY FRANK SMITH.

THE SIXTEENTH ANNUAL REPORT OF THE DEPARTMENT OF CLIMATOLOGY.

The work should be of importance not only to those who are seeking a healthful climate and sanitary conditions, but of great importance to the ranchman and merchant. Upon the climate the farmer or ranchman depends for his living and the merchant depends upon the farmer.

The instruments used are the same as those used at all meteorological stations. When it is possible, two or more instruments are used to check on each other, so it is almost impossible to make a mistake in reading.

Readings are taken at 7 a. m. and 7 p. m. Some instruments are so arranged as to read at noon, but most of them are read morning and evening.

It will be noticed from the following tables that the highest temperature of the year 1906 was on August 16th, about 12:30 p. m., and the coldest day was March 16th, at about 4 a. m.

The greatest daily range, 49°, occurred on December 2, when the temperature changed from 7° to 56°, giving the coldest and warmest day of the month. Prevailing wind was southwest, 23 per cent of all the wind coming from this direction. The greatest precipitation in 24 hours was .43 inch, March 11; highest monthly precipitation, 2.09 inches, in September; least monthly precipitation, .05 inch, May. The total precipitation for the year was 12.57 inches.

Since the last report two instruments have been added to our equipment, a Solar Radiator, which is an instrument to tell the effect of sunshine on the air, and a Terrestrial Minimum Thermometer, to show the radiation of heat from the

earth. These instruments have not been in use long enough to give data for tables of results.

PRECIPITATION AND TEMPERATURE, 1891-1906.

	Precipitation	Temperature		
		Mean	Highest	Lowest
1891	13.92	40.9	83	—13
1892	12.73	40.5	85	—29
1893	3.84	40.6	87	—9
1894	7.63	39.9	88	—27
1895	11.15	38.5	87	—30
1896	12.80	41.4	84	—27
1897	12.48	39.6	85	—30
1898	7.63	38.9	88	—23
1899	11.84	38.8	87	—40
1900	8.53	42.6	91	—27
1901	8.52	40.2	92	—23
1902	7.73	40.9	91	—18
1903	10.37	40.1	84	—8
1904	9.58	41.8	84	—16
1905	9.76	40.3	91	—42
1906	12.57	44.6	88	—19
Average	10.06	42.5	. . . .	. . . .

WIND RECORD.

Months	Total miles	Direction	Miles	Hrs.	Min.
January	7,566	North	6,405	720	50
February	8,494	Northeast	4,499	365	00
March	9,756	East	8,720	666	40
April	10,154	Southeast	18,295	1563	20
May	10,637	South	11,116	1236	15
June	11,085	Southwest	25,474	1611	05
July	7,863	West	17,335	1079	55
August	7,911	Northwest	18,975	1387	55
September	7,621				
October	9,398	. . . .	110,819	8640	00
November	10,177				
December	10,157				
Total	110,819				

NOTE.—Five days in January register did not work.

SUMMARY OF 1906 BY MONTHS.

	Temperature							Precipitation			Days								
						Means													
	Max.	Date	Min.	Date	Means	Max.	Min.	Total	Greatest in 24 hours	Date	Clear	Partly clear	Cloudy	Dew point	Relative humidity	Vapor pressure	Sunshine in per cent	Snowfall	Barometer, average
January	52	31	−11	21	25	37	12	.58	.45	14	13	18	0	13	72	.140	73	7.10	22.661
February	54	28	−4	4	27	40	15	.05	.05	13	12	15	1	14	70	.143	76	.50	22.982
March	58	31	−21	16	25	36	14	1.01	.58	27	7	15	9	19	83	.130	88	6.10	22.782
April	69	22	10	2	40	52	28	1.75	.43	7	12	9	9	28	73	.256	50	6.35	23.027
May	74	19	19	1	47	61	34	.91	.25	27	16	11	4	36	63	.322	51	....	22.961
June	84	16	26	20	55	70	41	1.71	.80	24	25	5	0	38	56	.432	86	....	23.086
July	82	20	37	4	60	74	46	1.75	.55	11	17	11	3	44	59	.512	92	...	23.300
August	88	16	35	8	62	78	46	.59	.20	22	17	9	5	45	60	.516	72	....	23.162
September	81	7	30	18	54	68	40	2.09	.90	16	17	6	7	30	65	.382	60	3.00	23.147
October	73	2	4	24	40	54	27	1.33	1.00	21	19	8	4	25	66	.328	73	14.00	23.127
November	58	15	−11	20	29	41	17	.41	.23	2	17	9	4	18	76	.156	69	4.85	22.992
December	56	11	7	16	30	41	20	.39	.25	5	15	9	7	19	71	.153	61	6.00	23.004
Average	..	..	...	..	44.6	..	..	12.57	...	..	187	125	53	28.1	67.8	.289	72	47.90	23.019

THE UNIVERSITY OF WYOMING

AGRICULTURAL COLLEGE DEPARTMENT

EIGHTEENTH ANNUAL REPORT

. . . OF THE . . .

U. S. Agricultural Experiment Station

. . . OF . . .

WYOMING

1907-1908

LARAMIE, WYOMING,
U. S. A.

WYOMING
Agricultural Experiment Station.

UNIVERSITY OF WYOMING.
LARAMIE

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F. A. SMITH, B. S.	Assistant Chemist and Meteorologist
RHODA G. HOUTZ	Clerk and Stenographer

*Resigned. †Appointments beginning 1908.

Letter of Submittal.

U. S. AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF WYOMING.

To the President of the University of Wyoming.

SIR:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating agricultural experiment stations, and the act of Congress approved March 16, 1906, known as the Adams Act, I have the honor herewith to submit the Eighteenth Annual Report of the U. S. Agricultural Experiment Station of Wyoming, for the fiscal year ending June 30, 1908.

J. D. TOWAR,
Director.

UNIVERSITY OF WYOMING, LARAMIE, WYO.,
Sept. 30, 1908.

Letter of Transmittal.

To the Honorable,
The Board of Trustees,
Of the University of Wyoming.

SIRS:—I have the honor to transmit herewith the Eighteenth Annual Report of the Director of the University of Wyoming Agricultural Experiment Station, for the fiscal year ending June 30, 1908.

CHAS. O. MERICA,
President.

UNIVERSITY OF WYOMING, LARAMIE, WYO.,
Sept. 30, 1908.

UNIVERSITY OF WYOMING,
OFFICE OF BOARD OF TRUSTEES,
LARAMIE, WYO., Oct. 1, 1908.

To His Excellency, Governor Bryant B. Brooks.

SIR:—In accordance with Chapter 51, Section 1, of the Session Laws of 1899, as President of the Board of Trustees of the University of Wyoming, I hereby submit to you that portion of the report of the Board of Trustees which refers to the Annual Report of the Director of the Agricultural Experiment Station and other members of the Station council, for the fiscal year ending June 30, 1908.

Respectfully submitted,
OTTO GRAMM,
President of Board of Trustees.

Table of Contents.

Report of the Station Staff.

Report of the Director.

In presenting the Eighteenth Annual Report of the Wyoming Experiment Station, it is perhaps well to note in the beginning that the important changes in the personnel of the station staff at the beginning of the year have in a measure quite seriously handicapped the work of the past season. As will be noted a little later, the Director, the Agronomist, the Animal Husbandman, and the Wool Specialist were practically all new to the work in this state, and the plans of the three former, at least for the season, had been practically all made and partly carried out when the new officials took up their work. The following pages will, therefore, disclose no distinctly new plans other than those which have been conducted in the past and which have been well known to the former readers of these reports. It was not until the 18th of July that the Director arrived at the institution, the 25th of August that the Agronomist came, and near the middle of September when the Animal Husbandman took up his duties. The work of taking notes on the field experiments, as planned and installed by the former Agronomist, had been entrusted to Doctor Nelson, the Botanist, and to Mr Nowell, the Irrigation Engineer, and the care of the live stock at the University Stock Farm had been entrusted into the hands of Mr. J. A. Hill, the Wool Specialist. It will thus be seen that the carrying out intelligently of any experimental work by the new men was to be undertaken with more or less difficulty. The results of the farming operations and field experiments will be

found in the report of the Agronomist, which appears later in this publication, while those of the Animal Husbandman are not herewith submitted, due to the fact that no important experiments in the live stock line have as yet been completed. The departments of chemistry and botany have continued faithful in their work and have published a very interesting bulletin on the forage plants of this State. The Irrigation Engineer, with his duties of collecting soil samples at the Cheyenne Farm and the conducting of experiments at the Laramie Farm, has completed one bulletin, which is described later on. No new work has in the past year been undertaken by the Botanist, and his connection with the Experiment Station has been to a certain extent severed by reason of the greater employment of his time by the University.

Experiment Station Staff.—Doctor Nelson, who has been connected with the Experiment Station since its organization, still continues in the capacity of Consulting Botanist and Horticulturist, but is not at present actively engaged in any particular experimental work. In a like manner Professor Ridgaway remains as Physicist, and continues as a member of the Station Council, and in an advisory manner is an important member of the Station Council. Professor H. G. Knight, the Chemist, devotes a considerable portion of his time to the Experiment Station work, although his efforts are divided between that of the Professor of Chemistry in the University and that of State Chemist. The institution enjoys the entire services of Mr. F. E. Hepner as Chemist, and he has devoted himself continuously to the Experiment Station, working on the soil moisture, Wyoming forage plant investigations, and digestion experiments. Mr. Herbert T. Nowell, the Irrigation Engineer, has carried on faithfully his duties in the department, conducting several important experiments in connection with the growing crops, particularly with barley, and

in collecting samples and in representing the Direcor in connection with the soil moisture experiments at Cheyenne and Newcastle. It is to be regretted that Mr. Nowell is about tó sever his connection with the department to take up work of a private nature in another part of the State. Mr. L. B. McWethy, B. S., came to the institution in the latter part of August from the Michigan Agricultural College, having graduated from that institution in 1904 and been connected with the Agricultural Department since. He undertook at once the completion of experiments planned and installed by his predecessor, and has prepared a report of these results, which appears later. Mr. T. F. McConnell was appointed Animal Husbandman early in September, and took up his work about the middle of the month. Mr. McConnell came from Wisconsin, where he has always resided, and brought with him a long experience in live stock work acquired at the university of that state and upon his own farm. Mr. McConnell, too, has signified his intention of severing his connection with the institution and will thus create another vacancy in the Experiment Station work. Mr. J. A. Hill, B. S., a graduate of the University of Wyoming, undertook the duties of Wool Expert at the beginning of the fiscal year. For the first three months of the year, his time was occupied in caring for live stock belonging to the Experiment Station. He undertook the organization and development of a department about the first of October, and his work in that line appears later in this report. Mr. F. A. Smith, the Assistant Chemist and Meteorologist, has continued through the year in the capacity mentioned, and his report as Meteorologist is found in the latter pages of this publication. Dr. Grace Raymond Hebard, who has for the past eighteen years been an officer of the Board and Librarian of the Experiment Station, has resigned the former, but continues as the Station Librarian in connection with her duties as Librarian for the

University. During the past year she has prepared the fourth index bulletin, designated as Index Bulletin D, which brings the indexing of the Station publications up to the beginning of the present fiscal year. Towards the close of the month of September, Mr. M. J. Hamilton, who had for several months occupied the position of Clerk and Stenographer, resigned, and his position was later taken by Miss Rhoda G. Houtz, who still continues as the efficient Clerk and Stenographer of the Director's office. The retirement of President Tisdel at the end of March and the appointment of the Director as President for the interim until a permanent president was appointed, somewhat interfered with the work of the Director. On May 9th, the Board appointed Dr. Charles O. Merica as President of the University, and he assumed his duties on the 11th, thus relieving the Director of the University work, although a short time later he was called upon to act as President during the absence of President Merica, and thus about two months of the Director's time was divided between the duties of President of the University and Director of the Experiment Station.

With the proposed retirement of the Irrigation Engineer and the Animal Husbandman, it will be necessary to elect new men to these positions, and thus again the work for the coming year of these two important departments will be more or less handicapped by the bringing in of new men wholly unfamiliar with the work of the past and with all their plans for the future to be formulated and put into operation. It is hoped that these positions will be promptly filled and that as little break as possible in the work of the two departments will thus result.

The Experiment Station Stock Farm.—In accordance with the following act the State Penitentiary buildings and land connected therewith were transferred to the University to be used as an Experiment Station.

(House bill No. 30.)

TRANSFERRING STATE PENITENTIARY BUILDINGS AND LANDS TO THE UNIVERSITY OF WYOMING.

AN ACT transferring the State Penitentiary buildings and lands connected therewith, near Laramie, to the University of the State of Wyoming, for the use of its Agricultural College Department for an Experiment Station, and making an appropriation of five thousand dollars for repairing said buildings and erecting other necessary buildings on said lands.

Be it enacted by the Legislature of the State of Wyoming:

USE OF AGRICULTURAL COLLEGE.

SECTION 1. That the penitentiary buildings near Laramie, Wyoming, and all lands connected therewith, and set apart and reserved therefor, as granted and donated by the Government of the United States to the State of Wyoming in Section 9 of the act of Congress, approved July 10th, 1890, providing for the admission of the State of Wyoming into the Union, are hereby transferred and donated, perpetually, to the University of the State of Wyoming for the use of its Agricultural College Department as an experiment station. Said lands and property shall be and remain under the control of the Trustees of the said University for the purposes aforesaid.

APPROPRIATION.

SEC. 2. There is hereby appropriated from any funds in the State Treasury, not otherwise appropriated, the sum of five thousand dollars, or so much thereof as may be necessary, to be used for the purpose of repairing, restoring and in other respects placing the buildings located upon the said grounds in proper and fit condition, and for the erection of other necessary buildings on said lands, for the use of the experiment station of the Agricultural College Department of the State University. Said funds are to be expended under the direction of the Trustees of said University.

SEC. 3. This act shall take effect and be in force from and after its passage.

Approved February 9th, 1907.

To distinguish this farm from the Agronomy Farm on which experimental work with field corps is conducted, it has been decided to name it the Experiment Station Stock Farm. Up to the time of appointing the Director and other members of the Experiment Station staff during the past year, very little work has been done in repairing the buildings of this farm and putting the place in shape for keeping the institution's live stock and carrying on experiments therewith. Upon careful inspection of all the buildings and the

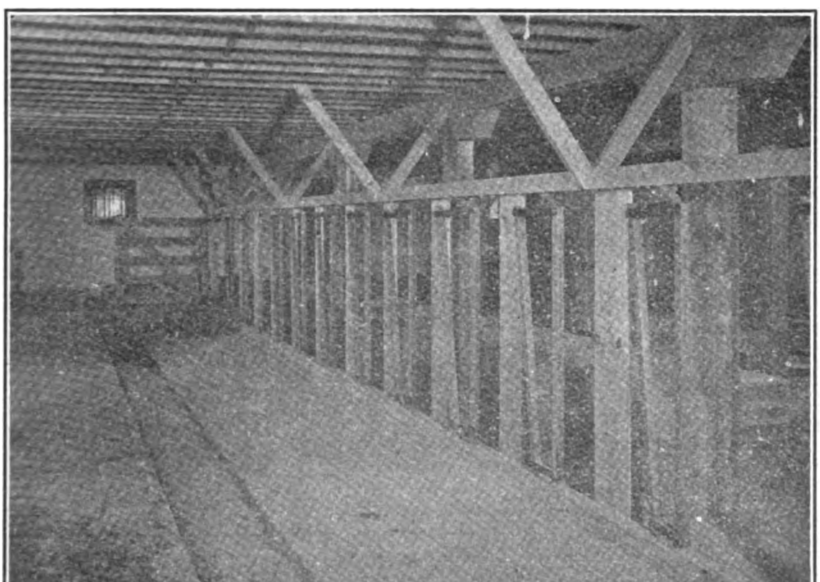
study of various plans for remodeling, it was decided that the most important things to undertake at first were the construction of suitable fences, the puting in repair of the two dwellings, the removal of the cells in the main penitentiary building, and the construction of feeding racks and pens for the accommodation of the live stock to be used in the experimental work. Last year a small sum had been expended in the construction of woven wire fences and in the installing of a system of water pipes whereby a water supply was furnished at the sheep feeding pens. With the appointment of an animal husbandman who should reside in the larger residence and of a herdsman whose home should be in the smaller residence, it was found necessary to make some repairs on these buildings. Accordingly the plumbing of the two buildings was made complete, a new floor was

Interior of old Broom Factory, fitted with sheep pens and feeding racks.

laid in the north room of the larger residence, wardrobes constructed, and other necessary repairs made. This, together with the painting and papering which seemed absolutely necessary, completed the expenditures of the fund on the residences. In the main penitentiary building there were forty-two brick cells constituting three stories of the north wing and an equal number of steel cells occupying the south wing. The work of removing these cells was outlined and specifications prepared and the contract offered to the lowest bidder. As the bids seemed unsatisfactory, the Director was instructed to employ help and have this work done by day laborers. Accordingly the work was undertaken and wherever the materials required were of sufficient quantity to warrant the same, bids for the supplies were received. In removing the brick cells from the north end it was found necessary to build supports for the roof before the brick could be removed from beneath, as the brick walls of the prison cells were furnishing part of the support of the roof. This was accomplished and then the work of removing the brick was begun. It was estimated that there were upwards of 200,000 brick in this structure, together with a large quantity of flag stone, cement, and iron used in the construction of these prison walls. The removing of these cells proved to be a tedious and expensive task, and yet the work was done at a saving of several hundred dollars on the lowest bid offered for doing the work. This portion of the prison was later converted into a stable for the dairy cows, with a matched floor above and a cement floor beneath, thus providing a very comfortable, well lighted, and convenient stable and a very large storage loft above. The stable is provided with a row of eighteen comfortable stanchions, a roomy feeding alley, and places provided for additional stalls for cows. The work of removing the steel cells which occupied the south end of the penitentiary building proved to be a less serious problem than at first anticipated. By means of boilermaker's chisels and a heavy sledge, it was possible to cut the rivets at a very

rapid rate and thus permit the work to proceed with dispatch. It was found that these cells were in such good repair and that they could be so taken down as to be readily re-erected. With this in mind, communication was made with the various cities of the State, and as a result, several of these cells were sold for city jails, and a very handsome return for the material was thus realized. A large quantity of the iron thus obtained, however, remains yet unsold, and up to the present time goes begging for a market.

The old broom factory, which had apparently been used for sheep pens and various other purposes, was converted into a series of pens and compartments, and suitable feeding racks constructed for each of these pens. The work of clearing out the rubbish and constructing a gravel floor in this building consumed a large amount of time and incurred con-



Interior of north wing of old penitentiary, converted into dairy stable.

siderable expense. The result, however, seems to have warranted the outlay, and at the present time we are provided with a most excellent equipment of pens and racks for taking care of our numerous breeds and grades of sheep. The upper story of this building provides room for the storage of hay and other roughage, and with a small room reserved for the shepherd's room, which is adjacent to the small lambing pens. has made a very complete and convenient building of this. That portion of the farm lying between the County road and the Laramie, Hahns Peak and Pacific R. R. has been thoroughly fenced with woven wire fence and a single line of barbed wire. This completes a much needed demand on that portion of the farm, and it is safe to estimate that with the funds available for the present year, we may be able to nearly complete fencing the entire property. It is planned to eventually convert the old penitentiary kitchen into an up-to-date dairy room. The room at the present time is practically in the same condition it was one year ago, with the exceptions of having its walls whitewashed and with separators and churns temporarily installed. Before a final plan for the proper utilization of this room can be perfected, it will be necessary to have more money in sight than we have at the present time. It is, therefore, decided to allow the room to remain in its temporary and unfinished condition. The large room in the second story, which was formerly used as a chapel, seems a very suitable place to install for the safe-keeping and for the exhibition purposes of our grain, wool, and other collections, which, at the present time, are being stored where they are neither used nor appreciated. Before this can be accomplished, however, more money will be required. There are various other ways in which the farm can be improved and the buildings arranged for the convenience and comfort of the animals necessary for carrying on the experimental work. The old log house is inconvenient, uncomfortable, unsightly, and unsanitary. It should be removed, and a suitable building

for the comfortable keeping of hogs for experimental purposes erected in its stead. The horse barn on the place is far too small for the accommodations of the horses which should be kept on the farm, and it, too, is so constructed that it is cold, unsanitary, and not by any means suitable for the demands of the institution. There are several other structures about the place which have practically no degree of usefulness whatever, and they should be removed and up-to-date structures erected in their stead. While the improvements made around these buildings do not seem to show very prominently to the casual observer, it cannot be said but what every dollar was honestly and judiciously expended, and that the reason why the work was not completed was on account of the lack of sufficient funds. It is earnestly hoped that another appropriation will be made whereby this work may be satisfactorily completed and the farm and buildings be placed in a condition suitable for carrying on carefully and conveniently the work of the Experiment Station.

Co-operative Sheep Breeding Experiment.—The co-operative sheep breeding experiment being carried on with the Department of Agriculture at Washington to secure a type of range sheep which shall be hardy, stand flocking in large numbers, shear a good fleece of wool, be of fair size and have a good mutton form, has been conducted during the past year under the plans outlined by my predecessor. The sheep have been kept on the King Brothers' ranch the entire year, and the breeding, care and lambing have all been conducted under actual range conditions. During the year the flock has been increased by the following purchases: One yearling ram from Markham and Chapman, New California, Ohio; one three-year-old ram from E. H. Moore, of Pontiac, Mich.; one three-year-old ram from Roscoe Wood, of Saline, Mich.; one yearling ram from R. A. Jackson, of Dayton, Wash.; and

two rams from George Truesdell, of Washington, D. C., thus making six very fine pure bred Rambouillet stock rams which are probably the equal of any six sheep of that breed to be found in any one place in the United States. At the beginning of the present fiscal year, there were 75 pure bred and high grade Rambouillet ewes in the breeding flock, and this flock has since been increased by the following additions: 30 ewes from Robert Taylor of Abbott, Nebraska; 12 from W. S. Hansen, of Collinston, Utah; 40 from R. A. Jackson, of Dayton, Wash.; 30 from the Butterfield Live Stock Co., of Wieser, Idaho; 60 from E. J. Bullard, of Fresno, California. These, together with 12 lambs from the first year's breeding, constitute the foundation stock at the present time. The contract with the F. S. King Brothers' Company, which was in effect last year, was renewed, and the sheep have been cared for and brought through the season with most excellent success, as every one of the sheep with which the experiment was begun was in the count at the end of the year. By terms of the contract with the United States Government the Animal Husbandman of the Exepriment Station, Mr. T. F. McConnell, became the officer in charge of this work. While the Experiment Station has undertaken this work and takes credit for its conduct, thus far very much of the planning has been entrusted to the officials of the Department of Agriculture, and as the experiment was originated by that Department and is practically its experiment, this station has gladly assented to the arrangements thus far proposed, which have been most wisely and carefully planned. It is the object of this experiment to eventually have some stock to distribute among the sheepmen of the state and nation, but as yet, the flock is in its formative state, and it will be some time before there is any stock for distribution. The crop of lambs for the present season is a very promising one and contains many most excellent specimens.

Wool Investigations.—With the possession of a complete wool scouring plant it is aimed to carry on investigations with wool, not only the scouring and reporting of the results to the sheep growers of the state, but to study in a systematic and thorough manner the numerous problems which are worrying the wool producers. Among the problems that have been undertaken during the past year are the following:

1. Investigations to increase the value of wool grown in Wyoming.
2. Study of the effects of various dipping fluids upon wool.
3. Study of branding compounds. The injury done to wool by the use of improper branding compounds is of greater enormity than one would think. Branding compounds can be applied which do not thus affect the wool and render it so much less valuable.
4. The scouring plant.
5. Sorting and grading of wool. It has long been known that one reason why the Western wools, and indeed, all the American wools, do not bring the highest market price, is because they are sent to market in such condition that enormous expense is incurred in grading and sorting the fleeces so that buyers may be assured of what they are purchasing upon examining a small sample of the sack.
6. Conditioning of wool, which means the comparison of the condition of wool as it leaves the railway station in our high, dry country as compared with its condition on arriving at the seaboard town. The Wool Specialist has worked faithfully and continuously during the entire year on these various problems, and while no bulletins have yet been produced, records of progress are in hand, and we hope later that the work of this depart-

ment will form a very prominent part of the research work of the station.

Pig Feeding Experiments.—Among the experiments undertaken and carried out during the past year is one aimed to compare the feeding value of barley, Indian corn, alfalfa hay, and other supplementary feeds, for the purpose of fattening swine. The high altitude of the Wyoming Experiment Station forbids the growing of Indian corn, but the possibilities of rye, barley, spelt, and field pease, grown on these high altitudes, taking the place of Indian corn are very promising. The quality of meat produced by these other cereals seems to be superior and thus far they possess fattening qualities which give promise of substituting most admirably for the Indian corn, which we are unable to produce. Further study of the feeding value of the cereals grown in the State is necessary before we can estimate the possibilities of stock feeding in Wyoming. Viewing the agricultural and pastoral situations of the State, it appears that as yet little has been done in the fattening of live stock. In the past, sheep and lambs and cattle have gone out of the State in such condition that they have brought low prices and have failed to give the producer anything near the full return for his effort, and a demonstration of the feeding value of the grains that we can produce either by irrigation or dry farming methods, appears to be one of the important duties of the Experiment Station.

Alkali Investigations.—Owing to the large quantity of seepage water which finds its way to the University Stock Farm, practically the entire surface soil has become so alkalized as to render it practically worthless. The work of reclaiming this land has been under consideration for a number of years, and it was not until the past year that any active work was undertaken to accomplish this end. After considerable correspondence with the Drainage Investigations

Department of the Office of Experiment Stations, a contract was entered into whereby the Experiment Station furnished the tile and the supervision of the work, and the Drainage Investigations Department planned the drains and paid for the work of installing the system. Experts from the Government office came to the farm and carefully laid out the necessary drains, and early in May the work of construction was begun. The main drain or outlet starts at a point about 810 feet north of the penitentiary building and runs in a southwesterly direction to the center of the adjacent field, a ten-inch tile being used; thence a branch continues in the same direction about 700 feet and another takes a more northerly course to the county road, the last five hundred feet of this line being of eight-inch tile. From the western branch a parallel eight-inch drain takes also a southerly course, thus providing two parallel drains practically the whole length of the field, intercepting the seepage water at a point a few rods from the west boundary and again along the central line of this portion of the farm. A few hundred feet of the upper ends of each of these drains is of six-inch tile. This work has incurred an expense to the Experiment Station of some $600, while about $900 has been expended by the Office of Drainage Investigations. Irrigation ditches, weirs, and division boxes have been constructed from the ditch leading from the Pioneer Canal, and the work of irrigating heavily with a view of washing out the alkali will be carried on during the coming summer. About 80 observation wells have been sunk in various parts of the drained area, and a measuring weir is placed at the outlet of the main drain. Thus with the co-operation of the Office of Drainage Investigations and the Chemical Department of the Experiment Station, it is planned to carry on this investigation to secure both scientifically and practically every result that can be obtained from this important work. In going about the State and noticing the action of seepage water on

land lying at levels lower than the irrigated areas, it appears that the alkali problem is one of the most serious ones that the irrigator has to encounter. It is confidently hoped that the result of this work will throw some important light on the subject and that it will also offer some means whereby the practical man can afford to reclaim his alkali-poisoned land or prevent the injury caused by this agency.

Farmers' Institutes.—During the past year it was planned to conduct the institute work in accordance with the law enacted at the last session of the Legislature, allowing the counties to organize for institute work and appropriate $100 towards the local expenses of these meetings. Copies of the law were sent to the county commissioners of every county in the State and letters urging the necessary action to perfect a county organization. Up to the present time the counties of Laramie, Albany, Johnson and Big Horn are the only ones that have perfected an organization in accordance with the state law, and regular institutes have been held in these counties. Failing to arouse the necessary interest in the remaining counties of the State to organize under the state law, attempts have been made in other ways to interest the farmers and ranchmen of these remaining counties in institute work, and for this purpose meetings have been called in Sheridan, Crook and Weston counties, but owing to the unfavorable weather at the time practically all of these meetings were unsuccessful. In each of these three counties there was a number of farmers interested in the movement, but as yet nothing has been done to complete an organization whereby permanent officers were elected or appointed to conduct the institutes in the future. Negotiations are in progress for conducting meetings in Converse, Natrona and Fremont counties, and it is hoped that at a favorable season in the autumn a series of institutes may be conducted in these counties. Thus far all attempts at holding meetings in the remaining three counties of the State have

been unsuccessful, and the outlook is thus rendered rather discouraging. However, the effort will be renewed the coming season in the hope that permanent organization in every county of the State may be created.

The counties of Wyoming are all very large, and it appears to be rather difficult to find localities in which the farms are thickly enough settled to get together any considerable number of people for an institute meeting. This is especially true of those parts of the State given up so completely to pastoral pursuits. In the more thickly settled districts, like Wheatland, Buffalo and the Big Horn Basin, the farmers' institute movement is in demand, and institutes in these localities are bound to succeed. Wherever these meetings have been held in the irrigated and more densely populated districts a good interest has been shown, and the meetings have been well conducted. Even if the endeavor the past year has not met with the success that we had hoped, there is every reason to feel that this movement needs to be carried on with even greater energy in the future. The State is rapidly being settled by families from the East, who are wholly unaccustomed to the conditions which prevail in our State, and it seems that a system of institutes or farmers' schools should be installed and carried on wherever there is a sufficient number of farmers to warrant the undertaking. Many of these new settlers are wholly unacquainted with the business of irrigating the land, while in the districts where dry farming is to be practiced, there is need of careful and thorough instruction on the principles of cultivation and care of crops to be grown under our western conditions. There is demand for scientific instruction along the various lines that are being undertaken by these new settlers, such as irrigation, dairying, stock feeding, stock breeding, control of alkali, rotation and cultivation of crops, veterinary subjects, and other questions of a scientific nature which may arise from time to time.

At the same time, there is an equally strong demand for instruction and demonstration of a thoroughly practical nature, for which men who have succeeded in agricultural lines in our State are best adapted to teach. The men from the East taking up land under these various irrigation projects are generally wholly unacquainted with the simple methods of irrigation and farming where water is applied artificially. These men must be instructed, and it seems that it is within the province of the State to devote a portion of its funds appropriated for farmers' institute work, to teach these new settlers these rudiments of agriculture. It is planned to devote a portion of the time and money allotted to institute work the coming year to just such teaching and demonstration as this. The experience of the past year has demonstrated that there is still a demand for such instruction as is usually given in farmers' institutes. In one of the counties application has already been made for a short winter course, and it is hoped this can be arranged for and carried out according to the demands. There are several dairying centers in the State, and in these it is hoped that the Animal Husbandman may visit and give demonstrations on the testing of milk and in the selection of dairy cows. In the irrigated districts it is hoped that the Irrigation Engineer may go and give practical demonstrations in the construction of ditches, the building of weirs, division boxes and gates, and in the practical application of water to the land. In the dry farming districts the farmers' institute movement contemplates the sending of an expert who will lecture to the farmers and impress upon them the importance of practicing the best principles for conserving the moisture and of handling the cultivated crop under the semi-arid conditions which prevail.

Below is given a list of institutes that have been held during the past year, the names of the speakers, together with the approximate attendance at each session.

Date	Place	No. of Sessions	Total Attendance	Lecturers
1907 Nov. 21, 22, 23 . .	Wheatland	7	925	Towar, McConnell, Dr. Cooke. Prof. Stoner, Prof. Nelson.
1908 Feb. 26, 27, 28.	Laramie. .	9	626	McWethy, McConnell, Dr. Cooke, Nowell, Prof. Stoner, Ridgaway, Gilkison, Nelson, Knight, Hill, Prien.
April 10, 11 . . .	Lovell. . .	4	340	Towar, Nowell, Prien.
April 13, 14 . . .	Worland . .	6	318	Towar, Knight, Prien, Nowell.
April 14, 15 . . .	Basin . . .	5	280	Towar, Knight, Prien, Nowell.
April 16	Otto . . .	3	167	Towar, Knight, Prien, Nowell.
April 17	Burlington.	3	210	Towar, Knight, Prien, Nowell
April 20, 21 . . .	Buffalo . .	6	453	Towar, Knight, Prien, Nowell.
April 22, 23 . . .	Sheridan .	2	40	Towar, Knight, Prien, Nowell.
		45	3359	

Institutes were planned for Sundance, in Crook County, and Boyd, in Weston County, but owing to the impassable condition of the roads and the inclemency of the weather, neither of these meetings was held. On the 5th day of May, the Director of Institutes and Professor Nowell attended a farmers' congress for Laramie County at Cheyenne.

The Director wishes to express here his appreciation of the interest and help of the officers of the counties in which institutes have been held, and to thank them for the assistance they have rendered in carrying on the institute movement in other localities to a success.

Publications.—Beginning, as usual, with the Annual Report, the Station has published during the past year five bulletins. A brief summary of these is as follows:

Seventeenth Annual Report of the Agricultural Experiment Station. The report consists of 142 pages devoted to a brief report of the progress of the work the past year by the Director, enumerating the lines of work that have been undertaken and are in progress, mentioning briefly the legislation of interest to the Station, reporting somewhat in detail the farmers' institutes, enumerating and summarizing the publications of the year. A financial statement of the treasurer is given in full, and the reports of the various depart-

ments follow. A very complete summary of the fence post experiment is printed in the annual report, together with the outline of the barley experiments, moisture investigations, and sundry other experiments and investigations by the Agriculturist. A brief report of the work of the Botanist is also included. In the report of the Chemist, the various bulletins published and the investigations under progress are outlined. The Irrigation Engineer goes somewhat into detail in describing the duty of water and drainage investigations, together with co-operative soil moisture work and irrigation extension experiments on the Government Dry Farm. The Animal Husbandman takes up in their order the horses, cattle, sheep and swine work, going into details in describing the range sheep breeding experiment in co-operation with the Bureau of Animal Industry of the U. S. Department of Agriculture. The Agronomist gives a somewhat detailed report of the yields and results in the several experiments conducted upon the Agronomy Farm. The report concludes with the report of the Meteorologist, giving the precipitation, temperature, wind record, and barometric average for the twelve months of the year.

Index D.—A complete index of bulletins 54 to 74 inclusive, prepared by the Secretary, is mailed to every name on the mailing list, thus affording those who care to retain the publications and bind them in book form, to include the numbers thus indexed together with the index in one volume.

Bulletin 75, on the Life and Preservation of Pitch Pine Fence Posts, 18 pages, by Prof. B. C. Buffum. This bulletin, outlined in the last annual report, is the result of sixteen years' trial of pitch pine fence posts which were treated in lots of five by sixteen different methods. This bulletin has attracted considerable attention throughout the entire country, and an extract from it has recently been published in one of the farmers' bulletins by the U. S. Department of Agriculture.

Bulletin 76, Wyoming Forage Crops and their Chemical Composition, Studies No. III, 120 pages, by the Botanist and Chemist. It consists of the botanical description and chemical analysis of seventy-two forage plants gathered at elevations ranging from 4,500 to 11,000 feet. The bulletin is unaccompanied by summary of any definite conclusions, as the publication is one of a series, and the work is not yet completed.

Bulletin No. 77, Experiments with Barley, 20 pages, by the Irrigation Engineer. In this the Irrigation Engineer goes into detail, showing the results of different methods of irrigating barley, and draws conclusions as to the quantity of water necessary for producing the most profitable yield at this altitude. It being the first and only experiment of its kind, the summary and conclusions are not definitely drawn, neither does the author decide as to the profit to be derived from the growing of this cereal. The results, however, give a very hopeful view of the barley growing industry and point to this plant as being one which will eventually prove not only profitable, but become universally adopted as a grain for stock feeding purposes.

Bulletin 78, Digestion Experiments with Wethers, 44 pages, by the Chemist and Animal Husbandman. The bulletin records results of carefully conducted experiments with the following forage crops: native hays, oat straw, pea hay, sweet clover, and alfalfa. The results are of manifest interest and offer many suggestions as to the feeding values of the forage crops grown on the higher altitudes. The plan to continue this experiment will probably be carried out the coming winter.

The Ranchman's Reminder.—This monthly publication has been kept up under the editorship of Mr. H. T. Nowell, who has been prompt with his publications and provided each issue with something new, interesting, and generally well illustrated. It is published as a magazine of the Agricul-

tural College, and affords opportunity for issuing articles and reports on agricultural subjects and experiment station works, many of which are not of sufficient importance to warrant their publication in a regular bulletin, but which are of sufficient local value to justify the expense of circulation.

Poultry Department.—There seems to be a considerable demand for information on poultry in this State. This demand for information is such that it cannot be readily answered because thus far, practically no experimental work has been done with any kind of poultry in this State. It seems that it would be a wise investment to devote a certain amount of the Experiment Station funds to the investigation of the possibilities of raising poultry in Wyoming. The State being so different from practically all of the other states in the Union, by reason of its high altitude, its short seasons, cold nights and the peculiarities of the natural feeds, some interesting work could be done which would result in profit to the enterprise in this State.

The Director's office is constantly being called upon to answer questions regarding poultry and there is a general demand that poultry investigations be carried on at the Experiment Station. I, therefore, recommend that a suitable appropriation be made for the erection of buildings and installment of a suitable plant for carrying on investigations along this line. It would seem that the work necessary to do with poultry can largely be handled by Experiment Station funds after the State provides the necessary lands and buildings for carrying on the work. Should the Agricultural Department of the University wish to enlarge on the plan and the scope of work of the man in charge, it could do so without hampering the plans of the experimental work and with comparatively small expenditure of the educational funds. There is ample room for the installing of such plan on the Experiment Station Stock Farm and it would add materially to the usefulness of the institution.

I have not attempted to work out the details of the plan, nor to place any estimate on the necessary expense, but will undertake this part of the work if the suggestion meets with the approval of the Board of Trustees.

The University Stock Farm.—The University Stock Farm came to us as a gift from the last legislature with an appropriation of $5,000.00 to repair and remodel the buildings, fences, water supply, etc. This fund is practically exhausted and there still remains much work to do before the place will be in suitable condition for carrying on such experimental work as the department wishes to conduct. The farm is not yet entirely fenced and many cross fences must be erected to provide pasture fields for the various classes of animals, and to set aside a certain portion of the farm for the cultivation of crops when the work of cleansing the land of alkali shall have been completed. The work of repairing and remodeling the old penitentiary building is not yet completed, while nothing whatever has been done to provide a suitable building for the care and comfort of the swine. While a fairly good dairy barn has been arranged out of the old penitentiary building, more yards and sheds, provided with feeding racks and watering troughs, will be needed for beef cattle. A convenient, commodious and comfortable horse barn is an imperative need, while many of the old patched up structures about the place are absolutely useless and should be removed to give place to more suitable buildings. At present the sheep sheds and yards are fairly adequate to our needs. The residence house on the place assigned to the Animal Husbandman should have a proper heating outfit, while a small sum could wisely be appropriated to improve the entire appearance of the farm.

The Agronomy Farm.—The Agronomy Farm which is located some two miles from Laramie, has, during the past year, been partially fenced with new woven wire and barbed

wire taken from the old fences, new posts being used entirely. This work is not completed and State funds will be necessary if this work is done at once, as the amount of the funds that can be used for permanent improvements in the Experiment Station funds are very limited. During the past year a considerable amount of time and money have been expended on the irrigation ditches, bridges, division boxes, and drives. These expenditures are classed with permanent improvements and the general up-keep of the two farms will, as a rule, exhaust the amount of Federal funds that we are allowed to expend in this way.

Next to a complete and stock proof fence around the farm, the most imperative need is a good barn. Experimental work carried on on this farm demands the use of five or six horses during the summer season and on the farm there is a large collection of agricultural implements, possibly more than necessary on the ordinary farm. To provide comfortable stables for the horses, house the tools, store the necessary hay and straw for the live stock, to shelter the crops between harvesting and threshing time, and to furnish a suitable granary and seed room, a good barn is very necessary. I have not figured out the details of this requirement but I wish to state that it is a place where an investment in the best of construction, especially for the granary and seed room, will be the most profitable. Should the proposition to have erected on the farm such a barn as I have described, meet with the approval of the Board of Trustees, I will endeavor to furnish suitable plans from which an architect can proceed with the drafting of the necessary plans and specifications.

In the following pages will be found the reports of the various departments of the Experiment Station.

Financial Statement of the Treasurer.

UNIVERSITY OF WYOMING.

AGRICULTURAL EXPERIMENT STATION

IN ACCOUNT WITH

THE UNITED STATES APPROPRIATION, 1907-1908.

DR.

To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ending June 30, 1908, as per Acts of Congress approved March 2, 1887, and March 16, 1906—

Hatch Fund	$15,000.00
Adams Fund	9,000.00

CR.

	Hatch	Adams	
By Salaries	$ 6,552.32	$4,473.81	
Labor	1,483.76	333.53	
Publications	1,509.96	....	
Postage and stationery	372.78	30.65	
Freight and express	249.17	175.87	
Heat, light, water, power	721.59	94.04	
Chemical supplies	239.27	328.94	
Seeds, plants, and sundry supplies	786.86	66.54	
Feeding stuffs	1,662.03	407.87	
Library	41.20	....	
Tools, implements, and machinery	194.92	35.05	
Furniture and fixtures	193.14	56.77	
Scientific apparatus	51.63	650.40	
Live stock	259.00	1,840.75	
Traveling expenses	297.83	253.90	
Contingent expenses	15.00	....	
Building and land	369.54	251.88	
Totals	$15,000.00	$9,000.00	$24,000.00

We, the undersigned, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1908; that we have found the same well kept and classified as above; and that the receipts for the year from

the Treasurer of the United States are shown to have been $24,000.00 and the corresponding disbursements $24,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887, and the Act of Congress approved March 16, 1906.

[Signed] OTTO GRAMM,
H. L. STEVENS,
A. C. JONES.

Attest:
GRACE RAYMOND HEBARD,
[SEAL] Custodian of Seal.

SUPPLEMENTARY STATEMENT.

DR.	Farm Products	Total
To receipts from other sources than the United States for the year ending June 30, 1908	$1,311.59	$1,311.59
CR.		
By publications	123.45	
Freight and express	140.31	
Feeding stuffs	359.32	
Scientific apparatus	90.00	
Traveling expenses	111.66	
Library	49.20	
Buildings and land	40.10	
Seeds and plants	42.50	
Furniture	34.50	
Balance	320.55	$1,311.59

Report of Chemists.

HENRY G. KNIGHT, FRANK E. HEPNER AND FRANK A. SMITH.

In the spring of 1907, another man was added to this department to aid in some of the work. His time was to be devoted in part to research work and in part to teaching. He also had charge of the meteorology for the Station. In this department his time has been devoted almost exclusively to soil moisture investigations and to helping with the forage plant and digestion work.

Besides the lines of investigation carried on during the year, 1906-7, two new lines have been taken up.

The problems which have occupied our attention during the past year may be discussed under the following heads:

I. Wyoming Forage Plants and Their Chemical Composition. (In co-operation with the Botanist.)
II. Digestion Experiments with Wethers. (In co-operation with the Animal Husbandman.)
III. Soil Moisture Determinations.
IV. Wool Investigations. (In co-operation with the Wool Expert.)
V. Alkali Investigations.
VI. Miscellaneous Work.

I. WYOMING FORAGE PLANTS AND THEIR CHEMICAL COMPOSITION.

The work along this line has been continued for the past four years. During the past two years seventy-two plants have been analyzed and the results obtained have been published in Bulletin No. 76, Wyoming Forage Plants and Their Chemical Composition—Studies No. 3. It is the intention

to carry on this work for some time yet that more complete data may be obtained. The work as carried on up to date has brought out some very interesting features.

Field Worked—That some idea may be obtained of the field worked during the past four years the following table is introduced, giving a broad classification and the number analyzed in each division:*

	Studies No. 1	Studies No. 2	Studies No. 3	Total
A. Native—				
I. Grass-like—				
1. True Grasses—				
a. Bottom lands	2	17	9	28
b. Bench lands	14	10	19	43
c. Mountains	—	—	13	13
2. Sedges.				
a. Bog	—	3	11	14
b. Dryland	—	1	1	2
3. Rushes	1	4	7	12
II. Not grass-like—				
1. The legumes—clovers, vetches, etc	3	2	5	10
2. Salt bushes	5	—	2	6
3. Sage brush, weeds, etc.	—	—	2	2
B. Introduced—				
I. True Grasses	1	1	2	4
II. Other than Grasses—				
1. Alfalfa, clovers, etc.	8	5	2	15
2. Salt bushes, etc.	3	—	—	3
	37	43	73	152

As will be noted by referring to the above table, a number of mountain forage grasses and bog sedges and rushes have been collected.

The crude fiber in the Wyoming Native Grasses is higher on an average than the crude fiber in Eastern grasses. As far as could be determined, the variations in altitude at which collections were made have little effect upon this constitutent, so there must be other causes than altitude which operate to produce this general change in the proportion of this constituent. The crude fat is found, in general, to be rather low, but does not seem to vary markedly with altitude. The

*Bulletin 76, Wyoming Forage Plants and Their Chemical Composition--Studies No. 3.

percentage of crude fiber in Wyoming forage is persistently high.

Nitrogen Question.—Since the percentage of nitrogen in Wyoming forage is very high and at the same time it has been found that the soils, at least around Laramie, contain a low percentage of nitrogen, there must be causes of which little is known, which operate to give this high constituent.

The forage plants analyzed at this station, in general, have shown a high percentage of nitrogen, averaging about 9 per cent of the water-free material when calculated as crude protein. On the other hand, all of the analyses of soils which have been made show a marked deficiency in nitrogen content.*

This seeming paradox throws the question open to speculation. Where do the forage plants throughout this vicinity of the arid region obtain their nitrogen to build up structures containing such an abundance of protein? A number of theories might be advanced. The root extension of the plant compared with the total weight of the plant may be comparatively large. The fertilizing action of rain and snow, carrying down nitrates and ammonia, may be large. In the case of certain plants the nitrifying bacteria may furnish the required amount of combined nitrogen, but as yet, the problem is unsolved, and opens up a line of investigation to take up in the future.

In the mountains the soil becomes, in general, scanty, and plants will be found growing in crevices in the rocks where

*NOTE—Thirty-four samples of soil were analyzed for nitrogen, taken rom various localities on the Experiment Station Farm near Laramie, with the following average results: Nitrogen .0587 per cent; Organic Matter, 3.701 per cent; Water, 1.974 per cent.

The highest percentage of nitrogen obtained was upon a sample with the following composition: Nitrogen, 1580 per cent; Organic Matter, 4.360 per cent; Water, 2 615 per cent. The lowest percentage of nitrogen was obtained upon a sample with the following composition: Nitrogen, .0281 per cent; Organic Matter, 3.875 per cent; Water, 2.460 per cent.

The highest percentage of organic matter was obtained upon a sample with the following composition: Nitrogen, .0635 per cent; Organic Matter, 5.145 per cent; Water, 1.880 per cent. The lowest percentage of organic matter was obtained upon a sample with the following composition: Nitrogen, .0320 per cent; Organic Matter, 2.610 per cent; Water, 2.110 per cent.

The samples were all from cultivated soil collected during the early spring of 1906.

A sample of virgin soil in the vicinity of the Experiment Station Farm collected at the same time as the above gave the following results upon analysis: Nitrogen, .0945 per cent; Organic Matter, 2.820 per cent; Water, 2.12 per cent.

we would hardly expect they could reach enough nourishment for subsistence. The nearer we go to the tops of the mountains the more scanty becomes the soil.

Humus at high altitudes under arid conditions is lacking to a marked degree, but it is a question whether this is true of the soils nearer the tops of the mountains. The small mountain parks and the crevices in which plants find a foothold are often beds of leafmold, and, although the soil may not cover very extensive areas, it may be very fertile. This would be especially true in the timber belt.

Occasionally, among the highest mountains a mountain park or swamp will be found having soil of great depth, and it is not an uncommon experience to be mired down in these parks and swamps when taking summer trips with teams.

The total precipitation in many cases is greater than at lower altitudes near the mountains.

The thirteen grasses collected at elevations ranging from ten to eleven thousand feet gave the following average composition:

Ash	4.85%
Crude fat	2.64%
Crude fiber	32.32%
Crude protein	10.95%
Nitrogen-free extract	49.24%

This is very close to the average composition of the forage plants collected at lower altitudes, but the crude protein runs about 2 per cent higher.

It is not easy to make comparisons to determine the change in nitrogen content of plants with change in altitude. Averages of large numbers of samples collected at various altitudes would have to be taken, or the same species should be collected from various altitudes. Then, again, a number of factors may enter in, which would have to be considered. What might be true in one locality at varying altitudes may not prove true in others. It is not permissible at the present time to discuss more than apparent general changes in composition.

It would be impossible to attempt the first method, considering the amount of work done, and in only a few cases can comparisons be made by the second method at the present time. The comparisons are few in number, but they all point in the same general direction—that the percentage of nitrogen increases with increase in altitude. A number of comparisons are given below:

Downy Oat-grass collected at ten thousand feet elevation contained 9.69 per cent crude protein; another sample collected at eleven thousand feet elevation containd 12.21 per cent crude protein.

Tufted Hair-grass collected at an elevation of about seven thousand two hundred feet (see Bulletin No. 70) contained 7.76 per cent crude protein. Another sample of the mountain variety growing on dry, stony land at an elevation of about ten thousand eight hundred feet contained 10.95 per cent crude protein, and another sample of the mountain variety (same variety as the preceding) growing in moist soil at an altitude of eleven thousand feet contained 17.95 per cent crude protein.

Spear grasses (see descriptions, Bulletin No. 76) at various elevations gave the following per cent of crude protein:

Seven thousand feet elevation	6.12%
Elevation little greater than above	7.71%
Elevation about same as above (past bloom)	5.34%
Seven thousand five hundred feet elevation (past bloom)	6.69%
Ten thousand five hundred feet elevation	8.62%
Eleven thousand feet elevation (past bloom)	9.67%
Eleven thousand feet elevation (past bloom)	8.68%

It is quite probable if the above spear grasses had been collected at the same period in their growth that a greater difference in protein content would have been shown.

Variable Sedge collected at an altitude of about seven thousand feet (past bloom) contained 11.28 per cent crude protein; a sample collected at about ten thousand feet (in bloom) contained 16.51 per cent crude protein.

Small-flowered Wood-rush (in fruit) collected at about ten thousand feet contained 8.85 per cent of crude protein. Spiked Wood-rush (a near relative to the above, in fruit) collected at an altitude of about eleven thousand feet contained 11.54 per cent crude protein.

The rushes and sedges collected at a high altitude (between ten and eleven thousand feet), all show a very high protein content; as is shown by the tables given below.

Average composition of three sedges collected between ten and eleven thousand feet:

Ash	6.57%
Crude fat	3.43%
Crude fiber	25.09%
Crude protein	15.53%
Nitrogen-free extract	49.38%

Average composition of four rushes collected at about the same altitude as the above:

Ash	5.49%
Crude fat	2.40%
Crude fiber	28.14%
Crude protein	11.92%
Nitrogen-free extract	52.05%

These rushes and sedges show a higher protein content than those collected at lower altitudes, but since such a few samples were collected, this may have been accidental.

At low altitudes the rushes and sedges are not considered of any practical value for feeding purposes. On the Laramie Plains (altitude seven to eight thousand feet) the native hays grown upon irrigated meadows are composed largely of rushes and sedges, and the hays made from them are highly prized by stock feeders. Stock is wintered upon this class of hay and does remarkably well. The analyses made and the digestion experiments so far conducted, point to the fact that stockmen are, in a measure at least, substantiated in their views.

It is quite probable that the rushes and sedges grown at still higher altitudes are still more nutritious, and from the

analyses it appears that they stand in value next to the legumes.

The salt bushes, which grow in soil strongly impregnated with alkali, so strong in alkali, in fact, that the ordinary forage plants will not grow, are peculiar because of the presence of large quantities of inorganic salts, as would be expected, and also because of the invariably high protein content. The percentage of ash is so large that in most instances they have a decided salty flavor when eaten. The high protein content may account for the fact that a number of them prove to be valuable forage.

The analyses of forage plants given in Bulletin No. 76, Wyoming Forage Plants and Their Chemical Composition, Studies No. 3, is appended with the data showing where each was collected and under what conditions.

FORAGE PLANT AN

(Compiled fro

	GREEN						AIR-DRY					
	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Agropyron Scribneri Vasey	45.29	2.11	1.63	17.10	5.35	28.52	5.82	3.63	2.82	29.44	9.20	[illegible]
Agropyron spicatum (Pursh.) Rydb	30.04	3.65	1.80	26.47	3.49	34.55	6.95	4.85	2.39	35.21	4.64	[illegible]
Astragalus bisulcatus (Hook.) Gray	75.49	2.02	0.35	7.05	4.33	10.76	6.38	7.70	1.33	26.93	16.56	[illegible]
Astragalus Bodini Sheld	81.62	2.09	0.42	3.77	4.19	7.91	5.51	10.73	2.13	19.40	21.56	[illegible]
Atriplex confertifolia Wats	66.70	8.45	0.51	5.96	4.26	14.12	8.57	23.21	1.39	16.36	11.69	[illegible]
Bromus inermis Leyss	52.54	2.95	1.29	14.00	4.49	24.73	5.44	5.87	2.56	27.90	8.95	[illegible]
Bromus marginatus Nees	59.09	3.02	0.73	14.65	4.23	18.28	5.42	6.99	1.69	33.86	9.78	[illegible]
Bromus marginatus Nees	31.22	5.20	1.13	24.80	7.61	30.04	5.32	7.16	1.56	34.14	10.47	[illegible]
Bromus Porteri (Coult.) Nash	30.08	4.55	1.31	26.50	5.50	32.06	5.01	6.18	1.78	36.00	7.47	[illegible]
Bromus pumpellianus Scribn	58.27	3.45	1.23	14.89	3.29	18.87	5.24	7.84	2.79	33.81	7.47	[illegible]
Buchloe dactyloides (Nutt.) Engelm	37.92	7.20	1.50	16.65	5.18	31.55	5.72	10.94	2.28	25.28	7.86	[illegible]
Calamagrostis canadensis acuminata Vasey	47.03	5.17	1.45	18.32	5.48	22.55	5.41	9.23	2.59	32.71	9.78	[illegible]
Calamagrostis purpurascens R. Br	58.25	1.81	0.98	14.83	3.55	20.58	5.85	4.09	2.21	33.44	8.00	[illegible]
Calamagrostis purpurascens R. Br	53.83	2.37	1.11	15.00	4.29	23.40	5.98	4.82	2.26	30.55	8.74	[illegible]
Carex athrostachya Olney	61.93	3.28	0.91	11.71	3.34	18.83	5.35	8.16	2.26	29.10	8.30	[illegible]
Carex athrostachya Olney	67.46	2.57	0.73	10.18	3.54	15.52	4.92	7.50	2.13	29.75	10.35	[illegible]
Carex athrostachya Olney	52.28	5.36	2.06	13.32	3.96	23.02	5.69	10.60	4.07	26.32	7.82	[illegible]
Carex Douglasii Boott	57.85	2.63	1.30	12.53	3.82	21.88	5.04	5.93	2.93	28.24	8.60	[illegible]
Carex ebenea Rydb	60.52	2.39	1.61	10.08	4.43	20.97	5.86	5.71	3.85	24.03	10.56	[illegible]
Carex lanuginosa Michx	63.81	2.95	0.89	11.12	4.57	16.66	5.63	7.69	2.33	28.99	11.91	[illegible]
Carex scopulorum Holm	68.78	2.18	1.00	6.89	5.89	15.26	5.66	6.59	3.01	20.81	17.80	[illegible]
Carex siccata Dewey	61.28	3.00	1.00	12.57	4.88	17.27	5.00	7.37	2.44	30.85	11.98	[illegible]
Carex siccata Dewey	66.04	2.83	0.69	11.50	2.33	16.61	5.17	7.89	1.92	32.11	6.52	[illegible]
Carex variabilis Bailey	67.58	2.36	0.86	10.63	3.66	14.91	4.94	6.93	2.52	31.18	10.72	[illegible]
Carex variabilis Bailey	71.17	1.92	0.86	7.98	4.76	13.31	5.40	6.31	2.83	26.19	15.62	[illegible]
Dactylis glomerata L	61.90	4.07	1.32	10.38	5.37	16.96	5.09	10.14	3.28	25.85	13.38	[illegible]
Deschampsia caespitosa montana (Schur.) Vasey	63.75	2.14	1.08	10.61	6.50	15.92	6.20	5.54	2.79	27.45	16.82	[illegible]
Deschampsia caespitosa montana (Schur.) Vasey	58.69	2.33	0.94	14.09	4.52	19.43	5.90	5.31	2.13	32.09	10.30	[illegible]
Distichlis spicata (L.) Greene	52.75	5.20	0.86	12.99	6.26	21.94	4.70	10.48	1.73	26.21	12.62	[illegible]
Eleocharis palustris (L.) R. & S.	73.16	3.14	0.38	8.44	3.07	11.82	4.94	11.10	1.35	29.90	10.85	[illegible]
Equisetum laevigatum A. Br	75.96	5.19	0.54	5.67	2.54	10.10	7.04	20.06	2.10	21.94	9.82	[illegible]
Eriocoma cuspidata Nutt	61.45	2.82	0.96	13.82	5.41	15.54	7.18	6.79	2.30	33.28	13.02	[illegible]
Graphephorum Wolfii Vasey	66.89	1.98	1.16	10.72	4.93	14.32	5.40	5.67	3.30	30.64	14.08	[illegible]
Graphephorum Wolfii Vasey	62.53	1.87	0.86	13.19	3.81	17.74	5.19	4.74	2.17	33.37	9.64	[illegible]
Hilaria Jamesii (Torr.) Benth	50.62	4.23	1.19	15.78	4.29	23.89	6.23	8.03	2.26	29.96	8.15	[illegible]

DDER ANALYSES.
lletin No. 76.)

WATER-FREE				
Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	When and Where Gathered, Soil, Altitude, and Condition of Sample
per cent	per cent	per cent	per cent	
2.99	31.26	9.77	52.12	Aug. 21, 1907, rocky ridge, Medicine Peak, about 11,000 feet. Past bloom.
2.57	37.84	4.99	49.39	July 15, 1907, edge of rocky cliff near Ft. Steele, about 6,500 feet. Over ripe and dry.
1.42	28.76	17.69	43.90	July 13, 1906, dry soil not far from ditch, Lookout, about 7,200 feet. In bloom.
2.25	20.53	22.82	43.04	July 13, 1906, dry banks of Laramie river near Lookout, about 7,200 ft. In bloom.
1.52	17.89	12.79	42.41	July 15, 1907, clay drift near Ft. Steele, about 6,500 feet. Only leafy stems taken.
2.71	29.50	9.47	52.11	July 19, 1906, Experiment Station plats, about 7,200 feet. Partly in bloom.
1.79	35.80	10.34	44.68	July 19, 1906, Experiment Station plats, about 7,200 feet. Past bloom.
1.65	36.06	11.06	43.67	Aug. 8, 1907, moist sides of canon near Jelm, about 8,000 feet. Past bloom.
1.87	37.90	7.86	45.86	Aug. 8, 1907, moist canon near Jelm, about 8,000 feet. About blooming period.
2.95	35.68	7.88	45.22	July 19, 1906, Experiment Station plats, about 7,200 feet. Little past bloom.
2.42	26.81	8.34	50.83	Aug. 18, 1906, Wheatland, about 4,700 feet. Rather ripe.
2.74	34.58	10.34	42.58	Aug. 10, 1907, wet river banks near Jelm, about 8,00C feet. About blooming period.
2.35	35.52	8.50	49.29	Aug. 21, 1907, rocky slope, Medicine Peak, about 11,000 feet. In bloom.
2.40	32.49	9.30	50.68	Aug. 21, 1907, rocky ridge, Medicine Peak, about 11,000 feet. Partly in bloom.
2.39	30.74	8.77	49.48	July 13, 1906, low land near Lookout, about 7,200 feet. In bloom.
2.24	31.29	10.88	47.70	July 13, 1906, moist soil near ditch, Lookout, about 7,200 feet. Near blooming period.
4.32	27.91	8.29	48.24	Aug. 11, 1907 moist bottom lands near Jelm, about 8,000 feet. Ripe.
3.09	29.74	9.06	51.87	July 13, 1906, moist soil near ditch, Lookout, about 7,200 feet. In fruit.
4.09	25.53	11.22	53.10	Aug. 21, 1907, dry hillside in timber near Medicine Peak, about 10,000 feet. Past bloom.
2.47	30.72	12.62	46.04	Aug. 10, 1907, wet draws near Jelm, about 8,000 feet.
3.19	22.06	18.87	48.90	Aug. 21, 1907, moist soil, top of ridge, Medicine Peak, about 11,000 ft. In bloom.
2.57	32.47	12.61	44.59	July 13, 1906, wet sandy soil, Lookout, about 7,200 feet. Little past bloom.
2.02	33.86	6.88	48.92	July 13, 1906, wet sandy soil, Howell, about 7,100 feet. Past bloom.
2.65	32.80	11.28	45.98	July 13, 1906, moist soil near ditch, Lookout, about 7,200 feet. Past bloom.
2.99	27.69	16.51	46.14	Aug. 22, 1907, in water, edge of lake, Medicine Peak, about 10,000 ft. In bloom.
3.45	27.24	14.10	44.53	July 19, 1906, Experiment Station plats, about 7,200 feet. In bloom.
2.98	29.26	17.93	43.92	Aug. 21, 1907, moist soil, top of ridge, Medicine Peak, about 11,000 feet. Partly in bloom.
2.26	34.10	10.95	47.05	Aug. 21, 1907, dry stony land, Medicine Peak, about 11,000 feet. In bloom.
1.82	27.50	13.24	46.44	July 13, 1906, wet sandy soil (alkali) near river, Cooper Lake station, about 7,000 feet. (Considerable adhering sand and dirt.) Partly in bloom.
1.42	31.45	11.41	44.04	July 13, 1906, at edge of river near Lookout, about 7,200 feet,(some adhering sand.)
2.28	23.60	10.56	42.00	July 13, 1906, moist banks of ditch, Lookout, about 7,200 feet.
2.48	35.85	14.03	40.32	July 15, 1907, moist sandy hummocks near river, Ft. Steele, about 6,500 feet. In fruit.
3.49	32.39	14.88	43.24	Aug. 21, 1907, dry, stony land, Medicine Peak, about 10,500 ft. Almost in bloom.
2.29	35.19	10.17	47.35	Aug. 21, 1907, dry, stony land, Medicine Peak, about 10,500 ft. In bloom, taller than above specimen.
2.41	31.95	8.69	48.39	July 15, 1907, rocky slope of hill and gravelly soil at base of cliff, Ft. Steele, about 6,500 feet. In bloom.

FORAGE PLANT AND

	GREEN						AIR-DRY					
	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	Water	Ash	Ether extract	Crude fiber	Crude protein	Nitrogen-free extract
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Hordeum nodosum L.	77.36	3.49	0.75	12.00	3.15	17.86	7.99	8.61	1.84	29.65	7.78	44.13
Juncoides parviflorum (Ehrh.) Coville	62.75	1.57	0.61	7.65	2.23	13.17	6.22	5.82	2.27	28.43	8.30	48.86
Juncoides spicatum (L.) Kuntz	74.77	1.73	0.98	10.37	4.50	21.38	6.66	4.15	2.35	24.84	10.77	51.33
Juncus longistylis Torr.	61.04	1.66	0.30	8.50	2.40	10.79	5.62	6.61	1.19	33.94	9.60	43.64
Juncus Mertensianus Bong	76.35	1.77	0.57	5.61	3.51	11.81	5.70	7.16	2.31	22.74	14.23	47.86
Juncus Parryi Engelm	76.73	1.49	0.88	12.57	4.86	20.10	5.58	3.52	2.07	29.75	11.51	47.57
Koeleria cristata Pers	60.10	3.24	0.88	17.61	2.93	19.91	4.33	6.95	1.90	37.80	6.29	42.73
Lupinus argenteus Pursh	55.43	1.84	0.72	6.11	4.90	9.07	5.61	7.66	3.00	25.50	20.42	37.81
Melilotus alba Desv.	...	...	...	...	...	...	7.81	10.75	1.58	24.75	15.74	39.37
Phleum alpinum L.	63.31	1.66	0.94	11.68	4.42	17.99	5.67	4.28	2.41	30.03	11.30	46.25
Poa brachyglossa Piper	58.45	3.04	0.79	15.10	2.54	20.08	4.99	6.94	1.80	34.54	5.81	45.82
Poa epilis Scribn.	57.76	1.71	1.04	14.22	3.64	21.63	5.29	3.83	2.34	31.89	8.16	48.49
Poa longepedunculata Scribn.	54.28	1.65	1.23	15.03	4.42	23.39	5.69	3.41	2.53	31.00	9.12	48.5
Poa nemoralis L.	52.34	4.40	1.23	13.98	3.19	24.86	5.57	8.73	2.43	27.70	6.32	48.5
Poa nevadensis Scribn	42.68	2.79	1.35	21.05	3.06	27.07	5.28	4.61	2.23	34.79	5.06	48.0
Poa rupicola Nash.	46.73	2.33	1.41	13.91	4.62	31.00	5.84	4.12	2.49	24.59	8.17	54.7
Poa serotina Ehrh.	55.93	3.13	0.91	14.27	3.40	22.36	5.04	6.74	1.95	30.76	7.32	48.19
Scirpus microcarpus Presl.	68.34	4.41	0.82	8.18	4.48	13.77	5.73	13.13	2.45	24.35	13.33	41.01
Spartina gracilis Trin	58.86	2.06	0.69	16.14	3.70	18.55	4.62	4.78	1.59	37.42	8.58	43.01
Sporobolus airoides Torr.	57.58	2.79	0.90	13.74	4.33	20.66	7.69	6.07	1.95	29.91	9.41	44.97
Sporobolus airoides Torr.	57.70	2.51	0.84	13.96	4.40	20.59	4.96	5.63	1.89	31.36	9.89	46.27
Trifolium Parryi Gray	70.76	3.05	0.77	5.69	5.27	14.46	7.14	9.70	2.44	18.07	16.72	45.93
Trifolium pratense L.	...	...	...	...	...	...	7.04	9.51	2.49	17.67	17.56	45.73
Trifolium repens L.	79.19	2.57	0.66	3.27	4.95	9.36	6.37	11.55	2.99	14.70	22.38	42.11
Triglochin maritima L.	85.10	2.65	0.36	4.10	2.79	5.00	5.52	16.81	2.28	26.01	17.66	31.72
Trisetum subspicatum (L.) Beauv	58.44	2.22	1.02	13.68	5.07	19.57	5.63	5.05	2.32	31.06	11.51	44.43
Trisetum subspicatum (L.) Beauv	56.21	2.29	1.22	14.22	4.24	21.82	5.94	4.92	2.61	30.55	9.11	46.81
Vicia linearis Nutt.	70.78	2.32	0.57	7.94	6.49	11.90	5.57	7.49	1.85	25.65	20.98	38.46
Barley	...	...	...	...	...	...	9.97	2.53	2.32	5.04	8.38	71.76
Barley, Bald	...	...	...	...	...	...	9.26	2.26	2.47	3.00	8.35	74.66
Corn, Yellow dent	...	...	...	...	...	...	8.95	1.54	4.06	2.10	9.45	73.90
Field pea hay	...	...	...	...	...	...	6.85	5.79	1.44	28.61	14.37	42.94
Native hay	...	...	...	...	...	...	5.13	7.70	2.31	30.51	6.45	47.90
Native hay (Wire grass)	...	...	...	...	...	...	5.99	6.59	1.98	32.04	5.81	47.59
Oats	...	...	...	...	...	...	7.94	3.70	4.97	13.53	9.33	60.53
Oat straw	...	...	...	...	...	...	4.53	15.17	2.09	30.19	3.86	44.16
Oat straw	...	...	...	...	...	...	6.31	6.87	1.21	36.16	3.59	45.86
Oilmeal	...	...	...	...	...	...	8.12	5.42	8.90	9.08	34.61	33.87
Spetz	...	...	...	...	...	...	8.78	3.10	2.47	7.20	9.52	68.93

)DER ANALYSES—*Continued.*

VATER-FREE				
Ether extract	Crude fiber	Crude protein	Nitrogen-free extract	WHEN AND WHERE GATHERED, SOIL, ALTITUDE, AND CONDITION OF SAMPLE
per cent	*per cent*	*per cent*	*per cent*	
2.00	32.22	8.46	47.96	July 15, 1907, rich, moist land near river, Ft. Steele, about 6,500 feet. In bloom
2.42	30.31	8.85	52.21	Aug. 20, 1907, low, marshy land, Medicine Peak, about 10,000 feet. In fruit.
2.52	26.61	11.54	54.88	Aug. 21, 1907, rocky slope, Medicine Peak, about 11,000 feet. In fruit.
1.26	35.96	10.17	45.60	July 13, 1906, wet soil near ditch, Lookout, about 7,200 feet. Past bloom
2.45	24.12	15.09	50.75	Aug. 22, 1907, wet, marshy land, Medicine Peak, about 10,000 feet. In bloom.
2.19	31.51	12.19	50.38	Aug. 21, 1907, dry hummocks, Medicine Peak, about 10,500 feet. Partly in bloom.
1.99	39.51	6.58	44.66	July 13, 1906, dry banks of river, Lookout, about 7,200 feet. In bloom.
3.18	27.01	21.63	40.06	July 13, 1906, dry land near ditch, Lookout, about 7,200 feet. In bloom.
1.71	26.85	17.07	42.71	——, 1905, Experiment Farm, in stack one year. Very rank in growth.
2.55	31.84	12.04	49.03	Aug. 21, 1907, dry hummocks, Medicine Peak, about 10,500 feet. In bloom.
1.89	36.36	6.12	48.33	July 13, 1906, low land near river, Cooper Lake station, about 7,000 ft. In bloom.
2.47	33.67	8.62	51.20	Aug. 21, 1907, dry, stony land, Medicine Peak, about 10,500 feet. In bloom.
2.68	32.87	9.67	51.16	Aug. 21, 1907, rocky slope, Medicine Peak, about 11,000 feet. Past bloom.
2.57	29.34	6.69	52.16	Aug. 11, 1907, moist, bottom land near Jelm, about 8,000 feet. Past bloom.
2.35	36.73	5.34	50.79	July 13, 1906, wet, sandy soil, Howell, about 7,100 feet. Past bloom and partly ripe.
2.64	26.11	8.68	58.19	Aug 21, 1907, rocky ridge, Medicine Peak, about 11,000 feet. Past bloom.
2.05	32.39	7.71	50.75	July 13, 1906, moist soil at Cooper Lake station, about 7,000 feet. In bloom.
2.60	25.83	14.14	43.50	Aug. 10, 1907, marshy land near Jelm, about 8,000 feet. Past bloom.
1.67	39.23	9.00	45.09	July 13, 1906, dry banks of river, Cooper Lake station, about 7,000 ft. In bloom.
2.11	32.40	10.19	48.72	July 15, 1907, dry hummocks, Ft. Steele, about 6,500 feet. In bloom. The most prominent grass on the Platte river at Ft. Steele.
1.99	33.00	10.41	48.68	July 13, 1906, dry land near river, Cooper Lake station, about 7,000 feet. Very young.
2.63	19.46	18.00	49.46	Aug. 21, 1907, moist, western slope, Medicine Peak, about 11,000 feet. Little past bloom, badly colored in curing.
2.68	19.01	18.89	49.19	Sept. 3, 1907, Experiment Station plats, about 7,200 feet. In bloom.
3.19	15.70	23.80	44.97	Aug. 29, 1907, rich, well irrigated lawn, Laramie, about 7,200 feet. Both flowers and fruit.
2.41	27.53	18.69	33.56	July 13, 1906, wet, sandy, alkali soil, river bank, Lookout, about 7,200 feet.
2.46	32.91	12.20	47.08	Aug. 21, 1907, rocky slope, Medicine Peak, about 11,000 feet. In bloom.
2.77	32.48	9.69	49.83	Aug. 21, 1907, dry hummocks near lake, Medicine Peak, about 10,000 feet. Partly in bloom.
1.96	27.16	22.22	40.73	July 13, 1906, dry river bank, Lookout, about 7,200 feet. Both flowers and fruit.
2.58	5.60	9.31	79.70	Used in feeding experiments, 1907–8.
2.72	3.31	9.20	82.28	Used in feeding experiments, 1906–7.
4.46	2.31	10.38	81.16	Used in feeding experiments, 1906–7.
1.55	30.71	15.43	46.09	Used in digestion experiment, 1907. Too ripe and stringy
2.43	32.16	6.80	50.49	Used in feeding experiments, 1906–7.
2.11	34.08	6.18	50.62	Used in digestion experiments, 1906–7.
5.40	14.70	10.13	65.75	Used in feeding experiments, 1906–7.
2.19	31.62	4.04	46.26	Used in digestion experiments, 1907. Grown on ranch near Laramie. Sample contained considerable sand.
1.29	38.60	3.83	48.95	Used in digestion experiments, 1907. Same as above but no sand.
9.69	9.88	37.67	36.86	Used in feeding experiments, 1906–7.
2.71	7.89	10.44	75.56	Used in feeding experiments, 1906–7. (A large number of hulls had been thrashed off.)

COMPOSITION OF SOIL TO COMPOSITION OF PLANTS.

It is unquestionable that the composition of the soil has an effect upon the plants which are growing upon it. If the soil is impoverished, it will grow weak and sickly plants. It is only when the plant food is available in sufficient quantities that the plants will thrive the best.

It was not possible to make collections of the soil from the different sections of the country while the material was being collected for this bulletin, and it may be possible that not only altitude, but the soil also, has different characteristics, which would have an effect upon the composition of the plants.

In the spring of 1906, two small neighboring plats of land at the Experiment Station Farm at Laramie were sown with barley. One of the plats was sown with sodium nitrate as a fertilizer. (It was unfortunate that no record was kept of the amount of nitrate sown.) It was noted that the barley from the fertilized plat was much darker in color than that from the other plat, and, thinking that this might be accompanied with a difference in composition, samples were subjected to analysis, with the following results:

Barley grown on soil fertilized with sodium nitrate:

ANALYSIS.

	Air Dry	*Water Free*
Water	10.87	....
Ash	1.69	1.90
Ether extract	1.97	2.21
Crude fiber	2.20	2.47
Crude protein	9.61	10.78
Nitrogen-free extract	73.66	82.64

Barley, same as preceding, but soil unfertilized:

ANALYSIS.

	Air Dry	*Water Free*
Water	11.31	....
Ash	1.70	1.92
Ether extract	1.87	2.11
Crude fiber	2.43	2.74
Crude protein	7.86	8.86
Nitrogen-free extract	74.83	84.37

As will be noted, the barley grown upon the plat sown with nitrates contained a higher per cent of protein than the barley grown upon the unfertilized soil.

II. DIGESTION EXPERIMENTS WITH WETHERS.

For the past two years digestion experiments have been carried on with Wyoming forage, using three wethers that the results obtained might be more closely checked. The summary of the work of the past two years as published in Bulletin No. 78, is given below.

III. SOIL MOISTURE DETERMINATIONS.

The moisture content of soils collected by the Dry Farm Department has been determined in this department. About fifteen hundred analyses were made during the past year. Work has also been taken up to determine the moisture content in connection with the alkali investigations given below.

IV. WOOL INVESTIGATIONS.

Investigations with wool have been taken up during the past year. It has been claimed by wool men throughout the East that the Wyoming wools do not show the strength of fiber that the Eastern wools do. Our investigations during the past year have shown that their contention is correct, at least, in a measure. Wyoming wools are peculiar in the fact that we have a dry back wool and it is this portion of the wool which shows the lowest tension strength.

The plan of the work which it is the intention of this department to take up in co-operation with the wool expert, is as follows:

I. The effect various reagents have upon the strength of wool fiber.

II. The relation of wool fat to strength of fiber, if any.

III. Determinations of proportion of wool fats and salts in Wyoming wools.

IV. Study of underlying principles of the variation of strength of wool fiber from the normal in range stock.

V. Co-operation in the general wool work as outlined by the wool expert.

A large portion of the time which has been devoted during the past year to this work has been utilized in working out methods to determine the best points at which to attack the problems outlined above.

V. ALKALI INVESTIGATIONS.

Alkali investigations have been carried on at this station for a number of years. The past spring the alkali land on the Stock Farm at the Experiment Station has been ditched and tiling put in place. It is the intention to carry on alkali investigations with this drained land. The work has just begun. About 80 test holes have been placed over about 50 acres of this land for making observations. The plan of work is as follows:

I. Determination of soil moisture.

II. Keeping records of the amount of irrigation water flowed upon the land and the amount of drainage water flowing off.

III. Analyses of the irrigation water and drainage waters for alkali.

IV. Determination of alkali in soil solutions.

V. Analyses of soil for alkali to determine change in alkali contents with respect to:

a. Time.
b. Amount of irrigation water flowed upon the land.
c. Crops.
d. Distance from tile drains.

VI. Variations in height of ground water.

VII. Change in character of the alkali and cause.

VI. MISCELLANEOUS WORK.

Under this head is included work done upon material sent in by those interested. Much of it will be of little or no value to the Station except as occasion arises when the notes can be used for reference. Occasionally this kind of work draws materially upon the time of the Station Staff, and in that respect must be taken into account. In no instance, however, has it been allowed to interfere with the regular work outlined in this department.

THE PLANS OF THE WORK FOR 1908 AND 1909.

I. Wyoming Forage Plants and Their Chemical Composition. (In co-operation with the Botanist.)

II. Digestion Experiments with Wethers. (In co-operation with the Animal Husbandman.)

III. Soil Moisture Determinations.

IV. Wool Investigations. (In co-operation with the Wool Expert.)

V. Alkali Investigations.

VI. Investigations to Determine the Comparative Keeping Qualities and Flavor of Drawn and Undrawn Poultry.

Report of the Botanist.

AVEN NELSON.

This department has again co-operated with the Department of Chemistry in the preparation of a bulletin (No. 76, Wyoming Forage Plants and Their Chemical Composition—Studies No. 3). Besides assisting in the collection of the grasses studied, they were determined and the descriptions, popular and technical, were prepared in this office.

The experiments with alkali and drought resistant forage were carried out only in part, and with no satisfactory results. Owing partly to climatic conditions, the percentage of germination was so low that the plats were in the main abandoned.

Very few of the trees in the experimental orchard came through the winter alive. There was practically no precipitation of any kind from October to May, and in consequence, the soil dried out completely. Water is not available from the canal during the winter months. The high winds of early spring extracted the last bit of moisture from the twigs and branches. The orchard was replanted this spring and most of the trees planted were making a nice start, but is now in a sorry-looking condition owing to leaflessness and broken twigs, caused by the hailstorm of July 18th.

There is much demand in the state for information concerning shade trees of an ornamental character. Heretofore, especially in the higher altitudes, the native cottonwood has been practically the only available tree. This is far from satisfactory from the ornamental standpoint, besides having some objectionable features. Therefore, at the suggestion of the Director of the Station, an experiment has been inaugurated to determine the availability of certain other trees for the higher altitudes (6,000 feet and upward). A plot of ground

was set apart below and adjacent to the main irrigation ditch for a small trial arboretum. The land was native virgin sod but was put into fair condition for our purpose with plow and harrow.

The varieties used for trial this season are (1) ten each of the following: Silver Poplar, Golden Willow, Mammôth Russian Willow, White Ash, Carolina Poplar, Smooth-bark Cottonwood, Black Locust. (2) Five each of the following: White Elm, Cork-bark Elm, Russian Olive, Norway Poplar, Hackberry. At the present writing most of them are in a satisfactory condition but for the injury due to hail.

The University campus is also incidentally being used for experimental grounds and a considerable number of trees, shrubs, and herbaceous perennials are on trial with more or less success. These experiments will serve to supplement the information secured on the regular plats.

The attempt to use for ornamental purposes certain native plants, while not wholly satisfactory, has shown that they possess qualities which make them very desirable. Scarcely inferior in beauty to any of the cultivated forms adapted to our climate, they possess a vigor and hardiness that may well compensate. Among those that have been successfully grown are the Rocky Mountain Blue Columbine; the Shrubby Atser, (*Xylorrhiza Parryi*); the beautiful flowering shrub, *Jamesia Americana;* a Beard-Tongue *(Pentstemon);* and the cruciferous perennial, *Stanleya Pinnatifida*. The two latter grow luxuriantly under cultivation and remain in blossom for a long time.

As Secretary of the State Board of Horticulture and also of the recently formed State Horticultural Society, this office has come into contact with all the phases of fruit growing in the State. The duties connected with each of the above positions draw heavily upon one's time, since the fruit and nursery business is just now in the formative period and many inquiries come to the Director and to the Botanist of the Station as well as to the Secretary of the above or-

ganizations. Since these inquiries are all referred to this office, the correspondence has been materially increased.

A special bulletin (No. 1), covering several phases of orcharding, edited in this office, was issued by the State Board of Horticulture some months since. This has proven useful in answering inquiries reaching the Station as has also the first biennial report of the same Board, issued in January, 1907. Questions relative to varieties, culture, spraying, etc., are best answered by printed matter and both of these publications have been distributed freely for this purpose.

The hundreds of letters sent out from this office have been in answer to inquiries in many fields. Plants and insects have been named; opinions have been rendered on the value or the destructiveness of this or that plant or crop, or pest; remedies have been suggested; formulae supplied; spraying advocated; bees discussed; and questions of all sorts answered as fully as time and the information at hand would allow.

The Botanist has held himself in readiness to assist at farmers' institutes. He participated in those held at Wheatland and at Laramie.

Having in charge, without any assistance, all the work in biology in the University and the Agricultural College, the time left for station work after the necessary teaching has been done is too limited to accomplish much outside of the routine work. This is especially true now that a summer term of six weeks has been added in which two or more courses in the biological subjects are offered.

Report of the Agronomist.

L. B. MCWETHY.

The arrival of the present Agronomist was in August of 1907. At that time the main experiments being carried on were variety tests of barley, oats, field pease and wheat. The grains on the farm were just beginning to ripen. During the fall these were harvested and threshed and the yields of the various varieties are found in the later pages of this report.

On the 31st of January the Farm Foreman, Mr. A. C. Musser, resigned. Beginning with the month of April, Mr. Duncan McMillan has filled the position very satisfactorily.

A brief account of the work at the Experiment Farm for this season may be of interest.

Early in the spring about 175 rods of new fence, a combination of woven wire and barb wire, were erected. There is still a need for about 250 rods more to adequately fence the place against range stock. This will be completed before another year has passed.

Along the road fences there were about 135 cottonwood and poplar shade trees set out, a portion of which are growing well. As these rows of shade trees are established they should add much to the beauty and value of the farm.

In the south field, on a new piece of land acquired by the Station, twenty-one quarter-acre plots were established and permanent pipe driven at their corners. It is the purpose of the Station to carry on a series of experiments in soil fertility on these plots. This year the entire series was planted to potatoes for the purpose of eradicating all weeds and determining the uniformity of the plots at the beginning of the experiment.

In the early spring, a survey of the experiment plots was made by two of the engineering students from the University and permanent land marks established at the corners of the acre plots. These are proving of great value in securing accuracy of work on the plots.

Before many of the experimental plots could be considered in mechanical working order, a large amount of work was needed in leveling and in repair of roads and irrigating ditches. This formed a large feature of the work during the spring months.

The following experiments are being carried on during the present summer:

1. Variety tests with the leading crops, oats, barley, field pease, potatoes, root crops, and alfalfa.

2. The relative value of fall and spring plowing for barley, representing a grain crop; for beets, representing a root crop, and for potatoes.

3. The value of nitrate of soda as applied to various crops is being tested. This should serve in the study of the soil as to its need for nitrogen to increase fertility.

4. The testing in a small way of numerous new varieties of oats, barley, and durum wheats. Breeding and selection for improvement in grains has been established. This will form an important feature of our work in the future. Acre plot 17 was devoted to this work.

5. The possibilities of vegetable gardening as an industry for this locality.

BARLEYS GROWN IN A VARIETY TEST AT WYOMING EXPERIMENT STATION, 1907.

Number of Variety	No. of sq. ft. in plot	Pounds of Barley	Pounds of Barley per acre	Bushels of Barley per acre
203	3894	142	1625.5	33.86
526	4214	129	1333.5	27.78
500	4214	81	841	17.52
496	4214	55	565	11.77
470	4214	122	1261	26.27
343	3915	164	2405.4	39.81
212	3297	122	1612	33.58
195	4214	173	1788.3	37.26
282	4214	107	1106	23.04
205	3979	172	1882	39.21
0	4214	197	2036.4	42.43
497	4214	58	599.6	12.49
270	4129	176	1857	38.68
167	3830	179	2036	42.41
510	4214	150	1550.5	32.30
508	4214	73	.....	....
37	2571	72	1220.1	25.41
345	1920	67	1520	31.67
35	1600	46	1252.4	26.09
424	933	26	1213.9	25.29
481	960	21	952.9	19.85
475	800	22	1198	24.96
231	907	16	768.4	16.01
230	960	31	1406.6	29.31
1	960	...	.....	....
375	2133	67	1368.2	28.51
455	2133	49	1001	20.85
18540	2133	19	388	8.08
19780	2133	37	755.6	15.74
19781	2133	37	755.6	15.74
19779	2133	14	285.9	5.96
19782	2133	21	428.9	8.94
19783	2133	23	469.7	9.78
20796	1067	20	816.9	17.02
504	2133	37	755.6	15.74
380	2133	60	1225	25.53
20909	666 2-3	23	1503	31.31
576	666 2-3	8	522.7	10.89
501	2133	13	265.5	5.53
413	2133	37	755.6	15.74
295	2133	29	592.2	12.34

REPORT OF THE OAT VARIETY TEST AT THE WYOMING EXPERIMENT STATION FOR 1907.

The Variety	No. of sq. ft.	Pounds of Oats	Pounds of Oats per acre	Bushels of Oats per acre	Date of Ripening
Delmane	6333	156	1049	32.77	Sept. 13th
Swedish Select	6333	192	1320.5	41.27	Sept. 15th
Kherson	6333	237	1630	50.94	Sept. 9th
Idaho	6523	207	1382.3	43.20	Sept. 13th
Black Beauty	2185	88	1754.4	54.82	Sept. 13th
Idaho	9500	295	1352.6	42.27	Sept. 13th

REPORT OF THE WHEAT VARIETY TEST AT THE WYOMING EXPERIMENT STATION FOR 1907.

The Variety	No. of sq. ft.	Pounds of Wheat	Pounds of Wheat per acre	Bushels of Wheat per acre
*1. Minn. 169	6331	127	873.8	14.56
†2. Minn. 169	6365	150	1027	17.11
3. Durum	6365	157	1074.5	17.91
4. Fife	6398	149	1014.5	16.91

*From Minnesota. †From Wyoming.

The oat varieties for this year were grown on alfalfa sod plowed over in the spring. They were irrigated only once. There was a heavy growth of straw, more heavy than the yield would justify. The best variety, the Black Beauty, was a side oat, and its grain was black. This was a handsome appearing oat, and the heaviest yielder. The next best variety of oats was the Kherson. This was 4 to 6 days earlier in ripening than the other varieties, which is a strong point in its favor. The straw was somewhat shorter and finer than the other varieties, but of good quality.

THE VARIETIES OF WHEAT.

There were four varieties of wheat in this test, occupying an acre plot. The varieties were late in ripening, and the frost came while they were still somewhat green. When the grain was threshed, it proved to be of inferior quality, unsuitable for market, and fit only for chicken feed. Among the varieties, the Durum was earliest in ripening, and somewhat the best in quality. The other three varieties were spring wheats. As a whole, the varieties on this plot were inferior in quality to the wheat grown on other nearby plots. The reason for this is not known.

Report of the Wool Specialist.

Prof. J. D. Towar,
Director of Experiment Station.

SIR:

I hereby submit a report of the work of the Wool Specialist for the fiscal year ending June 30, 1908.

The work of the year may be classified under three heads, as follows: Wool Scouring, Fiber Investigations, and General Educational Work. The study of dipping compounds was commenced, but it will be discussed under Fiber Investigations.

Wool Scouring.—As stated in the seventeenth annual report, a wool scouring plant was installed at the Experiment Station in the spring of 1907. When the plant was in readiness for operation, letters were sent to all the sheep owners in the State, offering them the privilege of having samples of their wool scoured free of charge and the shrinkage reported to them. Wool was very high in price last year, and sold so very readily that only a few ranchmen took the trouble of sending any samples to be tested.

The table which follows shows the wool scouring that was done in the summer of 1907 and the shrinkages of the samples tested.

TABLE SHOWING WOOL SCOURING RESULTS FOR 1907.

Wool Grown by	Address	Clip	Fleeces	Raw Wt.	Scoured Weight	Shrinkage	Date Secured	Remarks
E. Sundier	Rawlins	1907	3	22½ lbs.	7 lbs.	68.9 per cent	......	Scoured by Prof. Buffum.
David Kidd	Casper	1907	1	19	6	68.4	......	Scoured by Prof. Buffum.
Warren Live Stock Co.	Cheyenne	1906	6	43½	18½	57.5	......	Scoured by Prof. Buffum.
A. A. Spaugh	Manville	1906	4	29½	13	55.9	......	Scoured by Prof. Buffum.
F. A. Whitney	Meeteetse	1906	1	Lost	6	....	......	Scoured by Prof. Buffum.
Souter	Lander	1907	3	38½	8½	77.9	June 9	
King Bros	Laramie	1906	1	23	8½	63.0	June 9	
King Bros	Laramie	1906	1	16	5½	65.6	June 9	
King Bros	Laramie	1906	1	16	7	56.2	June 9	
King Bros	Laramie	1906	1	18½	5½	70.3	June 9	
King Bros	Laramie	1907	1	13½	3	77.8	July 2	
King Bros	Laramie	1907	1	14½	4	72.4	July 2	
King Bros	Laramie	1907	1	11	3½	68.2	July 2	
King Bros	Laramie	1906	1	17½	6½	62.9	July 2	
King Bros	Laramie	1906	1	24	8	66.7	July 2	
King Bros	Laramie	1906	1	25½	8	68.7	July 2	
Cromburg Bros	Medicine Bow	1907	3	32½	10	69.2	July 27	Yearling ewe.
Cromburg Bros	Medicine Bow	1907	3	35½	12½	64.8	July 27	Aged ewe.
Cromburg Bros	Medicine Bow	1907	3	44	15	65.9	July 27	2 yr. old wether.
K. MacDonald	Seminole	1907	1	9	2½	72.2	Aug. 7	Yearling.
K. MacDonald	Seminole	1907	1	8	2½	68.7	Aug. 7	Yearling.
K. MacDonald	Seminole	1907	1	9	3	66.7	Aug. 7	Aged ewe.
K. MacDonald	Seminole	1907	1	7½	2½	66.7	Aug. 7	Aged ewe.

It will be seen that a part of the scouring included in the table was done before the beginning of the year included in this report and a part was done by Professor Buffum before the writer took charge of the wool department. However, since none of the results were published in the annual report of last year, they are included here.

The table shows very strikingly the wide difference in shrinkage that is found in the wools of Wyoming.

In April of the present year another circular letter was sent to the sheepmen of the State, telling them once more that they could have samples of their wool tested for shrinkage without expense to themselves, except the cost of transportation to and from the scouring plant.

In the letter they were asked to send one full bag, if possible, because it would require at least that much to give a reliable test on the average sized clip of Wyoming. They were also cautioned to use the utmost care to see that the samples sent in represented their clips fairly. Otherwise the results of the tests would be apt to mislead both themselves and the buyers.

Wool is cheap and sells slowly this season, consequently more samples have been received for testing than there were last year. The greater part of the wool received has been scoured, but the results will not be tabulated until the work of the season is finished, when they will be filed away and published in next year's annual report.

The ranchmen do not seem to be as deeply interested in the shrinkage of their wool as might be expected, when we take into consideration the wide range of shrinkages to be found in the wools of Wyoming and the great differences in value which they cause. One would think that each of the large owners would gladly send a bag of wool to be tested in order to satisfy themselves of the true value of the clip and thus be in a position to sell it intelligently.

It is impossible at present to say just how much the shrinkage tests do benefit the wool growers, for so far the

only man to report results either positive or negative is Mr. A. A. Spaugh, of Manville, Wyoming. He says that he received one cent per pound more for his entire clip than he could have sold it for if he had not known the shrinkage. It is possible that others may have been helped as much or even more than this but have said nothing about it.

Whether the activities of the Experiment Station in wool scouring should be increased or diminished can easily be determined by the interest which the sheepmen of the State take in the work that is done along this line the next year or two.

Wool Fiber Investigations.—Along with other lines of work which were planned for the year was the study of the effect of sheep dipping compounds upon the character of wool. The first work was to be a study of the effect of dipping upon the strength of fiber. To carry out this plan samples of clips were secured from manufacturers who very generously donated enough for the purposes of the experiments. A fiber testing machine was purchased, and preliminary experiments were begun for the purpose of finding out the number of tests necessary to determine the mean breaking strain of any particular sample of wool. It was soon found, however, that this was not as simple a matter as had been at first supposed from reading the works of other men. Matthews* says, "A fair test of average breaking strain and elasticity may be obtained for any quality of fiber by testing about ten separate fibers and taking the mean of the total tests. If the quality of fibers, however, in a sample does not run very uniform, it is best to increase the number of tests to 25 or even 50, in order that a satisfactory average may be obtained." McMurtrie, as shown in his book entitled "Wool and Other Animal Fibers," used only fifteen individual fibers for getting the average tensile strength of a sample of wool.

It was thought at first that perhaps the mean breaking strain of one hundred fibers would give the average strength of a

*Textile Fibres, page 274.

a sample of wool. In order to test this, a sample of three-eighths blood Ohio, a wool which seemed to have a very uniform strength of fiber, was used; and the breaking strains of one thousand separate fibers were taken. The fibers tested were separated into groups of one hundred each, called first hundred, second hundred, and so on, in the order in which the tests were made. The arithmetical mean of the breaking strains of each hundred was found and also the mean breaking strain of the entire thousand. They are given in the following table:

Hundred	*Breaking Strain*	*Remarks*
1st	10.98 grams	....
2d	10.80 grams	....
3d	11.16 grams	....
4th	10.54 grams	....
5th	11.01 grams	....
6th	10.05 grams	Lowest
7th	11.66 grams	Highest
8th	11.56 grams	....
9th	10.96 grams	....
10th	11.42 grams	....
Mean of 1000	11.014 grams	....

The table shows a wide variation in the means of the different hundreds. The highest is 5.87% higher, and the lowest 8.75% lower than the mean of the entire thousand, making a difference of 14.6% between these two extremes. It would be impossible then to draw any reliable conclusions concerning the effect of dip upon the tensile strength of wool from such uncertain data as would be furnished by testing one hundred fibers of a sample before and another hundred after dipping.

It was then thought that the relation between the breaking strain and the diameter of the fibers might give a more reliable basis for comparison. For the purpose of trying this, one thousand fibers of Pennsylvania half blood were tested by measuring the breaking strain of each fiber on a testing machine and its diameter on a micrometer scale under a microscope. The means of the separate hundreds were kept as before, and they are given in the following table:

Hundred	*B. S.*	*M. R.*	*Diameter*	*B. S.* / *D*	*B. S.* / *D*²
1st	6.559 gr.	6.57μ	21.9	.2995	.01366
2d	6.977	6.87	22.9	.3047	.01330
3d	6.614	6.62	22.1	.2996	.01358
4th	6.624	6.56	21.9	.3025	.01380
5th	6.388	6.30	21.0	.3042	.01448
6th	6.754	6.65	22.2	.3042	.01373
7th	6.905	6.85	22.8	.3028	.01330
8th	7.152	6.86	22.9	.3123	.01365
9th	6.999	6.79	22.6	.3097	.01372
10th	6.720	6.42	21.4	.3140	.01467
Mean of 1000	6.769	6.65	22.17	.3054	.01379

The column headed B. S. gives the breaking strain in grams, and the one headed M. R. gives the micrometer reading, or in other words, the diameter in units of the micrometer scale. The next column shows the micrometer reading reduced to units of length, designated by the sign μ, one μ being one thousandth of one millimeter. The columns $\frac{BS}{D}$ and $\frac{BS}{D^2}$ give the relation of the breaking strain to the diameter and the square of the diameter, respectively. It would be supposed from the laws of mechanics that the breaking strain would be proportionate to the square of the diameter. A study of the table shows, however, that the breaking strain is more nearly proportionate to the diameter. The table following shows the difference between the highest and lowest values for the breaking strain and the breaking strain divided by the diameter and the diameter squared, respectively, that are found in the preceding table:

	B.S			B.S / D			B.S / D²		
	Value	Variation	Per cent	Value	Variation	Per cent	Value	Variation	Per cent
Highest	7.15	.381	5.63	.3140	.0087	2.85	.01467	.00088	6.38
Lowest	6.39	.379	5.60	.2995	.0058	1.90	.01330	.00049	3.55
Diff. of Extremes	.76	.76	11.23	.0145	.0145	4.75	.0137	.00137	9.93

In each of the three sections, the first column contains the values of the highest and lowest means, the second shows their variation from the mean of the entire thousand, and in the third this variation is expressed as per cent of the mean of the thousand. The lower line gives the difference between the two given above. This table shows that one hundred fibers are not enough to use for the purpose of determining the average tensile strength of a sample of wool, even if the diameter of the fibers are measured and taken into consideration.

A series of calculations was then made with the data already obtained to determine the number of tests necessary to give the tensile strength of a sample of wool with sufficient accuracy for the dip studies. This was done by finding what is known as the standard deviation of the sample, and then using the standard deviation as a basis on which to calculate the probable error for any given number of tests. The standard deviation is found by means of a long and somewhat complicated process, and little benefit would be gained by explaining it here. Therefore, simply the results will be given.

The standard deviation of Pennsylvania half-blood, calculated from the breaking strains and diameters of one thousand fibers is as follows: Standard deviation of the breaking strain equals 1.843 grams; of the breaking strain divided by the micrometer reading, equals 2.058; and of the breaking strain divided by the micrometer reading squared, equals 0.4443. The micrometer reading is not reduced in these calculations, because the co-efficient of variability remains the same, no matter what kind of units are used to express the length of diameter. In the following tables and formulae the micrometer reading will be indicated by M. R.

From the standard deviation the probable error of the mean of any number of tests is found by using the formula, $\pm E = \pm \frac{\text{Standard deviation}}{\sqrt{n}} \times 0.6745$. Where $\pm E$ is the probable error and n the number of tests made.

Taking the case which is under consideration, in which n equals 1000, the following values for $\pm$ E are obtained. The probable error of $\frac{\text{B. S.}}{\text{M. R.}} = \pm\ 0.0437$ or 0.43% of the mean, the probable error of $\frac{\text{B. S.}}{\text{M. R.}^2} = \pm\ 0.00945$ or 0.59% of the mean, and the probable error of B. S. $= \pm\ 0.393$ or 0.58% of the mean.

Probable error may be briefly explained in this way: When the probable error of the mean breaking strain of one thousand tests, which may be called an approximate mean, is $\pm$ 0.0393 grams, then the chances are even that this approximate mean is not more than 0.0393 grams, higher or lower than the true mean. There is also the same chance that the difference between the approximate and the true means is greater than the probable error, but when the limit of difference is increased to two, three, or four times the probable error, the chances that the difference between true and aproximate means is not greater than the limit rapidly decrease.

The following table shows the chances that the true and approximate means will not differ by an amount greater than $\pm$ E, $\pm$ E, etc.

$\pm$ E the chances are even.
$\pm$ 2E the chances are 4.5 to 1.
$\pm$ 3E the chances are 21 to 1.
$\pm$ 4E the chances are 142 to 1.
$\pm$ 5E the chances are 1,310 to 1.
$\pm$ 6E the chances are 19,200 to 1.
$\pm$ 7E the chances are 420,000 to 1.
$\pm$ 8E the chances are 17,000,000 to 1.

Taking the value of $\pm$ E for the mean breaking strain as found from the test of one thousand fibers expressed in per cent of the true mean, we find from the table that the

chances are about 17,000,000 to 1, that the difference between the true and approximate means is not more than 4% of the true mean. From another one of the laws of chance, we find that the chance that two consecutive approximate means obtained from the breaking strains of one thousand fibers will not differ from each other more than 4% of the true mean is more than 10,000 to 1. If then, judging from this one sample, the dip experiments are run in duplicate, the data obtained would certainly have a very high degree of reliability, and could be safely used as a basis from which to draw conclusions.

It will be safe to say, therefore, that one thousand fibers are enough to use for finding the mean breaking strain unless the coefficient of variability is considerably greater than that of the sample of wool used in these calculations. The next question that arises is: Will it be necessary to test one thousand fibers? The following table, which gives the probable error for different values of n, the number of tests, which are based on the standard deviations, already calculated for the sample of Pennsylvania half blood, will help in answering the question

TABLE SHOWING FOR DIFFERENT VALUES OF N THE PROBABLE ERROR EXPRESSED IN PER CENT OF THE MEAN.

n	$B.S.$	$\frac{B.S.}{M.R.}$	$\frac{B.S.}{M.R.^2}$
1	18.39%	13.61%	18.75%
100	1.84	1.36	1.88
200	1.30	.96	1.33
400	.92	.68	.94
500	.82	.61	.84
600	.76	.56	.77
700	.70	.51	.71
800	.65	.48	.66
900	.61	.45	.63
1000	.58	.43	.59
1100	.56	.41	.57
1200	.53	.39	.54
1300	.51	.38	.52
1400	.49	.36	.50
1500	.48	.35	.48
2500	.37	.27	.38
10,000	.18	.14	.19

The column marked n gives the number of fibers to be tested, and the other three columns give the percentages of probable error for the various values of n. From this it can be seen that the reliability of the approximate mean as compared to the true mean, which is shown by the decrease of the probable error, increases quite rapidly from 100 to 700, and that above 700, this increase in reliability is relatively slow, showing that there is very little to gain in reliability by increasing the number of tests to above 700. Since, however, it is better to test too many than too few, and since 1,000 is a very convenient number to use in making calculations, it is quite probable that 1,000 will be the number used unless further experiments show that some other number is better.

A comparison of the percentages in the different columns shows that the percentages of probable error of the mean of the breaking strains divided by the micrometer readings is less when n equals 600 than the probable error of the mean of the breaking strains when n equals 1,000. This would seem to indicate that both the breaking strain and the diameter of each fiber should be measured, but taking into consideration the fact that it requires more than twice as much time to measure both the breaking strain and diameter as it does to measure only the former, it is plain that it is more economical to test 1,000 fibers for the breaking strain alone than to test 600 for both. It is planned to find the standard deviation and probable error of other samples of wool before the experiments with dip are begun.

The method of finding the probable error of the mean by the use of the standard deviation, has been taken almost entirely from a bulletin entitled, "Type and Variability in Corn," by Davenport and Rietz, of the University of Illinois, and it is only fair that the authors should receive the credit to which they are due.

GENERAL EDUCATIONAL WORK.

Besides the work outlined under Wool Scouring and Wool Fiber Investigations, this department has done some general educational work. The most important part of this work was the gathering and classification of a wool exhibit that is very probably unsurpassed in the United States, unless it be by one or two collections of wool and wool products owned by textile schools along the Atlantic seaboard. It contains samples of all the various kinds and grades of wool from the principal wool-producing countries of the world, together with a collection of fleeces and parts of fleeces representing nearly all the commercial grades grown in the United States and also samples showing wool in every stage of manufacture, from the raw state until it becomes finished cloth.

The Experiment Station is greatly indebted to the F. S. King Brothers of Laramie, who paid the cost of collecting the exhibit, and the completeness of the collection is due to the painstaking care of F. M. Jennings, instructor in wool sorting and grading at the Philadelphia Textile School. The wool exhibit was shown at the Albany County Fair, the Wyoming State Fair, and the Wyoming Wool Growers' Convention. A part of it is now on exhibition at the University Museum, and the remainder will be kept on display as soon as the necessary room and suitable cases can be secured.

In addition to the informal talks explaining the wool exhibit to people who were interested, the Wool Specialist gave two lectures at the Albany County Farmers' Institute, and wrote a few short articles for the Ranchman's Reminder.

PLANS FOR NEXT YEAR.

I. *Operation of the Scouring Plant.*—The Experiment Station should continue to scour samples of wool for the ranchmen who take enough interest to send them in. By so doing, the owners of the wool will be benefited and the Station will be able to gather valuable data on the shrinkage of Wyoming wools.

II. *Study of the Effect of Dipping upon Wool.*—Before this can be done, however, it will be necessary to do more work to determine the best method to follow in order to get the average tensile strength of the wool before and after dipping.

III. *Study of the Influence of Wyoming Soil, Water, and Climate upon the Character of Wool.*—This study should be commenced by taking samples of wool from sheep in Wyoming for a year or two, and afterwards sending these same sheep to Ohio or Pennsylvania and taking samples in the same manner after the sheep are in their new environment. Other sheep from Eastern wool-growing states should be brought to Wyoming and placed upon the range, samples being as carefully taken before and after the change as in the first case.

IV. *Study of Branding Compounds.*—There is great need for a substance to be used in marking range sheep that will withstand the weather well enough to perfectly identify the sheep and still not cause so much trouble and expense to the manufacturer as do the paints and tars which are now used.

V. *Study of the Effect of Breeding upon the Character of Wool.*—The Station has a flock containing representatives of all the principal breeds of America and England. These offer an excellent opportunity to study the effect on the character of wool which is produced by different crosses. This should be carried out by means of shearing tests, scouring tests, and sorting tests, together with a study of the individual fibers.

VI. *Study of the Effect of Climate upon the Water Content of Wool.*

VII. *Co-operation with the Chemistry Department in the Study of the Chemical Composition of Wool.*

The preceding outline is intended to include not only the work for next year, but to serve as a plan for the wool investigations of the Experiment Station for a number of years to come. And it is quite probable that in the next year there will not be a chance to begin all the lines of study that are mentioned.

Very respectfully,
J. A. HILL.

Report of the Irrigation Engineer.

HERBERT T. NOWELL.

The work of the Irrigation Engineer for the year 1907-08 was chiefly in experimental research. A few University classes were conducted, and several Farmers' Institutes participated in by him. Most of the time, however, was occupied in field and office work.

Experiments were conducted at the Agronomy Farm along the following lines:

I. Experiments on the duty of water.
   1. Amount of water for maximum crop of brewing barley.
   2. The duty of water on plats.

II. Comparison of methods of applying water.
   1. The flooding method.
   2. The furrow method.
   3. The check method.

III. Soil moisture investigations.
   1. At Laramie.
   2. At Cheyenne.
   3. At Newcastle.

Besides the experimental investigations above, the following lines of work were undertaken by this department:

I. DRAINAGE OF THE STOCK FARM.

Surveys were made of the Stock Farm and contour maps of certain parts of the farm, a few test wells were dug, and a plan for draining about one hundred acres was formulated, the drains located, and an estimate of cost was made. In accordance with these plans, the Experiment Station decided to undertake the work of draining the farm, and about one thousand feet of tile drain was purchased in the fall of 1907. In the spring of 1908, however, an agreement was made with the Drainage Investigations of the United States Department of Agriculture for co-operation in this work. In accordance with this agreement, a Drainage Engineer from the Department was sent to Laramie, and he located a system of drains for the reclamation of a larger part of the farm than was at first contemplated. The Drainage Investigations agreed to bear the expense of construction, while the Irrigation Engineer of the station superintended the work of construction. This work was completed June 30th, 1908, at a total cost for the drains of about 13.5 cents per lineal foot. This cost was somewhat larger than expected on acount of the very heavy rains during May and June. Difficulty was experienced along a large part of the line with cave-ins, the gravelly subsoil when wet falling in constantly and leaving the edge of the ditch at the surface unsupported. This, unless held by crib work, would then fall in; consequently a large amount of cribbing was made necessary. The tiles were laid by means of a small drainage level on a slope of about six feet to the mile. A little over a mile of tile drains was constructed, and more than one thousand feet of shallow open drains were put in to furnish an outlet for pools of water which had gathered on the surface. Some ninety test wells lined with tile drain and averaging between four and five feet in depth, were also constructed for an investigation of the movement of sub-surface water and of alkali on the farm. This investigation is to be carried on by the Department of Chemistry.

II. REPLATTING A PART OF THE AGRONOMY FARM.

A section of the Agronomy Farm, which was first used in the season of 1907 for crops, was platted for experimental purposes. With the help of the Agronomist, permanent iron stakes were placed at the corners of these plats.

III. EDITING RANCHMAN'S REMINDER.

Publication.—The agricultural magazine of the station was edited by the Irrigation Engineer for 1907-08. The results of the experiments for the season of 1907 on the amount of water for maximum crop of brewing barley and also the comparison of the three principal methods of applying the water used on plats of bald barley, were given in Bulletin No. 77, Irrigation of Barley, issued by this department in May, 1908. The conclusions reached in these experiments are herewith quoted.

"1. Brewing barley varies widely in yield according to amount of water applied in irrigation.

"2. From experiments on six plats given different quantities of water, the highest yield, 35.32 bushels per acre, was obtained from a plat receiving 19.56 inches in depth of water supplied in three irrigations during the season.

"3. From these and other experiments on duty of water for barley, it seems that best results are obtained in irrigation of barley when from 16 to 20 inches in depth of water is applied.

"4. The quality of barley for brewing purposes is injured by too much irrigation.

"5. The growth of barley is only slightly delayed by irrigating.

"6. Rainfall during the season of the experiments, from May 9th to September 10th, 1907, was 7.09 inches. For other conditions of precipitation, the irrigation might be adjusted accordingly, but the practical irrigator rarely takes rainfall into account.

"7. The furrow method of irrigation proved most satisfactory, compared with flood and check methods, in results obtained. Its first cost was higher, but labor of irrigation less than with either of the others.

"8. Furrows should be not less than 16 inches apart. At 8 inches apart the first cost is too large for the practical farmer."

DUTY OF WATER RECORDS.

The records of the duty of water on plats at the Experiment Farm were continued and the results are given below.

SYNOPSIS OF DUTY OF WATER ON IRRIGATED PLATS AT THE WYOMING EXPERIMENT FARM.

AVERAGE DEPTH IN INCHES APPLIED IN IRRIGATION ON ALL PLATS.

	1902	1903	1906	1907	Average
1. Alfalfa	20.030	18.404	12.773	18.209	17.354
23. Sugar Beets	22.418	20.886			21.652
5. Wheat	13.560			9.382	11.471
3. Alfalfa with other hay	10.452				10.452
2. Young Alfalfa			6.332		6.332
6. Wheat and Oats	13.387			1.996	7.691
22. White Sweet Clover	9.828		9.764		9.796
21. Salt Bushes	12.000				12.000
18. Peas and Vetch	1.454				1.454
29. Carrots	11.074				11.074
20. Grasses in Plats	7.441	9.937			8.689
19. Brome Grass		19.330			19.330
14. Millet	13.952				13.962
11. Corn and Rape	11.906				11.906
16. Mixed Grains		13.763	12.064		12.913
9. Oats and Vetch		9.305			9.305
13. Spelt		12.258			12.258
8. Oats and Peas		14.215			14.215
24. Potatoes		11.679	8.928	5.781	8.796
25. Turnips		17.137		8.75	13.694
26. Garden Vegetables		4.485	25.054		14.769
27. Rutabagas		20.867			20.867
15. Flax		7.363			7.363
12. Rape		11.757			11.757
4. Alfalfa and Rape		9.266			9.266
28. Cabbage		7.120			7.120
10. Barley		25.368		13.154	19.261
17. Field Peas			16.636	6.656	12.646
7. Oats				16.465	16.465

SOIL MOISTURE INVESTIGATIONS.

During the season of 1907 the investigations of soil moisture at the Government Farm at Cheyenne were continued in co-operation with the Irrigation Investigations of the

United States Department of Agriculture. As some changes were made in the plan of farming operations, changes were also made in the system of taking samples of soil, both to conform with the changes in plats and to reduce the labor so that an assistant would not be required. Instead of taking the average of the soil from between two and twelve inches, twelve and twenty-four inches, and twenty-four and thirty-six inches as was done last year, the whole sample raised from the following depths was taken: The first sample was taken from six to nine inches in depth, and the second in each hole, was from eighteen to twenty-one inches in depth. Thus, only two samples were taken from a hole. More plats, however, were sampled than last year, so that the total number of samples taken each week, regularly on Wednesday, was seventy-two.

The objects of the soil moisture investigation remained the same as last year and were, in brief, to find the minimum amount of soil moisture which would keep the crops alive, and, also, so far as could be determined without regular notes on the condition of the crops, the minimum amount of soil moisture at which the plants would continue to grow and thrive. Also, to determine the average amount of moisture in the soil during different periods of plant growth, and the general comparison of the amount of the soil moisture in the field with the rainfall, and evaporation from tanks.

It was hoped in some degree, to get a comparison of the percentage of soil moisture with the yield of the different crops. Samples were taken at regular intervals so that diagrams might be made and the percentage of soil moisture charted, at equal spaces thereon, so that the behavior of the moisture in the fields might be seen graphically.

As this work is done in co-operation with the Government, and as the results of the first year's experiments were published in the Seventeenth Annual Report, it has seemed best to postpone the publishing of the results of this work for

1907 and 1908 until the complete results of the farm operations shall have been published by the Department of Agriculture.

Arrangements were also made to obtain samples from the Demonstration Farm at Newcastle, conducted by the Irrigation Investigations. Each week during the season, Mr. Mahoney, the foreman of the farm, sent by express to the University, several samples of the soil from different plats on the Newcastle farm. The determinations of the soil moisture were made by the Chemistry Department of the University, and the data gathered was treated in the same way as that gathered at Cheyenne.

At the Experiment Farm in Laramie, the Irrigation Department made a few soil moisture determinations each week from samples collected in the fall on a field of brewing barley, known as "Field B." The results of this work not being in co-operation with the United States Department of Agriculture, are here published. The great variation shown in the moisture on the same plats are due to some extent to the unevenness of the irrigated plats, but will give a general idea of the average percentage of soil moisture in the several plats at the time the samples were taken.

PERCENTAGE OF MOISTURE TO DRY SOIL.

Date	Plat No. 1		Plat No. 2		Plat No. 3		Plat No. 4		Plat No. 5		Plat No. 6	
	Sample No. 1 Depth 6-9 in.	Sample No. 2 Depth 18-21 in.	Sample No. 3 Depth 6-9 in.	Sample No. 4 Depth 18-21 in.	Sample No. 5 Depth 6-9 in.	Sample No. 6 Depth 18-21 in.	Sample No. 7 Depth 6-9 in.	Sample No. 8 Depth 18-21 in.	Sample No. 9 Depth 6-9 in.	Sample No. 10 Depth 18-21 in.	Sample No. 11 Depth 6-9 in.	Sample No. 12 Depth 18-21 in.
1907	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
July 20 . .	4.3	16.3	9.1	8.7	12.9	12.3	12.7	11.2	8.8	13.9	18.9	16.3
July 27 . .	8.7	11.9	13.7	22.3	16.8	17.7	9.9	11.0	9.2	9.7	18.8	16.5
Aug. 5 . .	6.0	8.2	14.6	13.1	13.8	15.6	21.6	15.2	13.1	12.3	15.8	15.5
Aug. 12 . .	6.3	9.6	8.5	15.3	14.1	11.8	19.3	15.0	6.5	12.4	11.8	10.6
Aug. 19 . .	4.8	5.8	5.7	11.3	11.8	9.9	6.7	8.8	7.7	5.4	18.8	13.1
Aug. 26 . .	5.2	5.5	5.6	8.7	7.9	9.2	15.7	16.1	3.8	5.4	8.6	9.6
Sept. 2. . .	5.4	5.8	6.5	7.5	13.5	8.6	9.1	7.6	6.5	9.7	4.9	9.4
Sept. 9. . .	4.2	7.2	4.9	7.3	5.8	6.8	4.6	5.5	7.0	9.1	9.9	9.9

IRRIGATION.

Date	Depth in inches	Date	Depth in inches	Date	Depth in inches	Date	Depth in inches	Date	Depth in inches	Date	Depth in inches
No irri-	gation	July 23	8.41	July 1-2 July 24	5.54 5.288	July 2 July 25 Aug. 12-13	6.082 6.381 7.100	July 3 and 5 July 26 Aug. 10 Aug. 17	8.524 5.838 5.876 6.049	July 5 July 13 July 19 Aug. 2 Aug. 9 Aug. 16	10.408 3.642 7.505 5.165 3.320 4.634
Total .	0	1 Irrig.	8.41	2 Irrigs.	10.828	3 Irrigs.	19.563	4 Irrigs.	26.287	6 Irrigs.	34.674

REPORT ON INVESTIGATION OF CROPS IN WYOMING.

As the localities devoted to farming in Wyoming are somewhat scattered, and as conditions in different parts of the state differ quite widely, it was attempted to find out from actual correspondence with the farmers of the state what crops were most profitable in the various localities, and in connection with these, the profit that might be expected from the various crops. A series of questions were put in the form of a circular letter which was mailed to some four hundred farmers of this state. A copy of the circular letter and the list of questions follows:

"DEAR SIR:—We are constantly receiving inquiries as to the most profitable crops under irrigation in different parts of Wyoming. You would aid us very greatly in obtaining this information if you will carefully fill in the blanks of the enclosed sheet. Please use reverse side of sheet for remarks. Estimates are wanted where accurate data are not obtainable. If you will be kind enough to do this, we will take pleasure in letting you know the results of this investigation.

"Yours very truly,
"H. T. NOWELL,
"Irrigation Engineer."

"QUESTIONS OF WYOMING CROPS.

Please fill out and return to H. T. Nowell, Laramie, Wyo.

1. Alfalfa ....(a) How many acres do you keep in alfalfa?
(b) What is your average yield per acre?
(c) Is it a reasonably certain crop in your locality?
(d) What would you estimate the annual profit per acre?
(e) Estimate depth of water applied in irrigating season.
(f) How many years do you think it advisable to grow alfalfa without replowing?

2. Native Hay ....(a) ....(b) ....
(c) ....(d) ....
(e) What proportion is "blue stem" or fine stemmed grass? ....

3. Other Forage Crop...(a) ....(b) ....
(c) ....(d) ....
(e) What crops? ....

4. Wheat ....(a) ....(b) ....
(c) ....(d) ....
(e) What varieties? ....

5. Barley ....(a) ....(b) ....
(c) ....(d) ....
(e) What varieties? ....

6. Oats ....(a) ....(b) ....
(c) ....(d) ....
(e) What varieties? ....

7. Other Grain Crop......(a) ....(b) Bushels per acre?
(c) ....(d) ....
(e) What crops? ....

8. Potatoes ....(a) ....(b) ....
(c) ....(d) ....
(e) What varieties? ....

9. Beets ....(a) ....(b) ....
(c) ....(d) ....
(e) What kind and how used?..........

10. Turnips ....(a) ....(b) ....
(c) ....(d) ....
(e) What use is made of them?.........

11. Other Root Crop......(a) ....(b) ....
(c)................(d) ....
(e) What kinds?.......................

12. Fruit ....(a) ....(b) ....
(c) ....(d) ....
(e) What kinds and varieties?..........

13. Any Other Crop......(a) ....(b) ....
(c) ....(d) ....
(e) What crops? ...."

The number of replies was not large, only about seventy-five answers being received. Many of these, however, went into the question very fully, and the results of this correspondence seemed to be of sufficient value for publication here.

Owen, Albany County.—Information is that the common alfalfa frequently kills out, but that the Turkestan alfalfa does well. All the common grains were reported as being successful crops. Vegetables do well. Eight kinds of apple trees are reported as being in bearing six years. Both the apple trees and berries of different kinds have been injured by hail.

Wheatland, Laramie County.—Several letters received. One farmer claims that intensive farming is necessary to yield a profit on land costing from $40 to $65 per acre. Some injury by hail reported on different crops.

One man having six acres of alfalfa averages three tons per acre. He claims it is a certain crop and that it averages $6 net profit per acre annually. He says that alfalfa will last as long as it is properly cared for, and that it does not pay, as a rule, to plow up good alfalfa. From one hundred acres in oats, he averages thirty bushels per acre which yields $10 profit. The varieties grown are Big Four and Side oats. They are a certain crop for this locality. From forty acres in Spelt he gets thirty-five bushels per acre which yields $12 profit, and it is reasonably certain in results.

Another farmer gives the actual results from well-kept records for the 1907 crop. From fifteen acres of alfalfa, he got four tons per acre, which paid him $10 net profit per acre. He gave it four good irrigations during the season and thinks it well to plow up alfalfa land after it has been in four or five years, so as to get the benefit of its fertilizing effect on the soil. From thirty acres of wheat he obtained thirty-eight bushels per acre, which gave him a profit of $17 an acre. He grew Pillsbury Hard Spring wheat and Blue Stem, and thinks they are a sure crop, except for hail. Twenty-seven acres of Kherson oats averaged sixty-five bushels per acre and yielded

a profit of $22. Ten acres of corn yielded forty bushels per acre, and it is a reasonably certain crop. Potatoes yielded an average of three hundred bushels per acre until they were attacked by blight. From one and one-half acres of fruit of various kinds he sold over $100 worth and had plenty besides for home use. From one-fourth acre of Prolific Marrow squash he obtained fifteen thousand pounds which he used as a stock food.

Another farmer, with one hundred acres of alfalfa, averaged about $10 per acre profit. He applied twenty-four inches in depth of irrigation water during the season. He thinks it advisable to plow up alfalfa land when it is about ten years old. On Velvet Chaff wheat he averaged twenty bushels per acre; Hulless barley, thirty bushels per acre; Swedish Select oats, fifty bushels per acre; World's Fair potatoes, two hundred bushels per acre.

Another man who uses forty acres of alfalfa as hog pasture, realizes from $15 to $25 per acre. He would plow up the alfalfa when three to five years old. Thirty acres of Minnesota Fife wheat averaged forty bushels per acre, and yielded a profit of $16 per acre. Eighty acres of Big Four and Swedish Select oats gave, in different years, thirty to eighty-five bushels. Twenty acres of White Pearl potatoes averaged two hundred bushels per acre. All of these crops are reasonably sure for this locality.

Another farmer has twenty acres of alfalfa which gave about three tons per acre yield, profit on which he estimates at $15. He irrigates from six to ten inches in depth during the season, and would plow up alfalfa when four years old. Ten acres of wheat averaged twenty bushels per acre and yielded a profit of $10 per acre. Beardless barley on two acres gave about the same yield. Twenty acres of oats at twenty-two bushels per acre gave a profit of $8 to $10 per acre in different years. Potatoes were attacked by disease and were not successful. Beets yielded about ten tons per acre and are estimated to be worth $5 per ton as a stock food.

Another man with forty acres of alfalfa obtains from two to four tons per acre according to the age, quality of soil, and the season. He finds it a very satisfactory crop and obtains a profit of from $8 to $10 per acre. He irrigates land until it is wet enough to stick a shovel in the ground with ease. He recommends plowing up alfalfa when three to five years old.

One other farmer has fifty acres in alfalfa yielding two tons per acre which gives him $8 per acre gross profit, or $4 per acre net profit. He applies about eight inches in depth of water during the season. He would plow up alfalfa when it is four years old. About twenty acres of 992 Minnesota Red wheat yielded eighteen bushels per acre and gave $10.80 gross profit. Twenty to thirty acres planted to oats in different years yielded twenty-six bushels per acre; $14 gross profit was obtained. Two feet of water was applied during the season. Ten to twenty acres of oats were planted in different years, the average yield per acre being twenty-five bushels, about $12 gross profit per acre. Both oats and spelt weighed forty-four pounds per bushel. He finds apples, plums, cherries, gooseberries and currants a success and reports never losing a tree except by girdling.

Eleven acres of alfalfa yield one and one-half tons per acre; is sure crop and gives a profit of $4 per acre. To obtain most benefit from fertilizing effect of this crop, it should be plowed up when two or three years old. One hundred acres native hay yields three-quarters ton per acre; is sure in returns and the profit averages $4 per acre. It is about half fine and half coarse stemmed grass.

Marquette, Big Horn County.—Eighty acres of alfalfa reported an average of three tons per acre and gave $15 an acre profit. It is a certain crop and if properly cared for will last a life time. He irrigates one and one-half feet deep during the season. Wheat and oats are raised with success but yields not reported. Five acres of potatoes averaged two

hundred and sixty-six bushels per acre. Cherries are raised with success in this locality.

Hilliard Flat, Uinta County.—Six acres of alfalfa yielded one and a quarter tons per acre at a profit of $8 per acre. Two irrigations are made during the season, and alfalfa should be plowed up when five years old. Ten acres in native hay average one ton per acre. Twenty acres in timothy gave one to one and a half tons per acre. Three acres in beardless barley yielded twenty bushels per acre. This is thought to be the best grain crop for this locality. Fourteen acres of oats yielded twenty-five bushels per acre, but it is an uncertain crop, having been frozen out three years in four.

Leo, Carbon County.—Ninety-seven acres of alfalfa are reported to average four tons in two cuttings, which gives a profit of $40 per acre. It is a certain crop for this locality. Irrigation water is applied two and one-half feet deep. Alfalfa at Leo is plowed up when it begins to dry out. The crops raised in this locality are all used as winter sheep feed. The principal crops raised are timothy, Defiance wheat, Beardless barley, Idaho oats, Early Ohio potatoes, beets, turnips, and a little spelt.

Buffalo, Johnson County.—From one hundred to one hundred twenty acres of alfalfa have averaged three and one-half tons per acre annually. This gives a profit of $10 per acre. It is irrigated to a depth of one and one-quarter to one and one-half feet. When six to ten years old, according to its condition, it is plowed up. It is a certain crop except for hail. It is largely used for pasture. Sixteen acres of wheat average twenty bushels per acre and yield a profit of $7 per acre. Several kinds of hard wheat for milling purposes are raised. Four or five acres of hulless barley yielded thirty-five bushels per acre. This and some corn raised was fed to hogs. Oats is a very reliable crop. Twenty-five acres in Iowa Silver Mine oats yielded forty bushels per acre, which gave a profit of $11 per acre. Lightning Express potatoes are

raised for home use. Sugar beets are of a very fine quality and give large yields. Mangels give a heavy yield. Small fruits are a great success, giving large yields. One to two irrigations are applied.

From fifty acres of alfalfa, five tons per acre were raised, giving a profit of $30 per acre. This was irrigated from two to four feet in depth. It is plowed up when four or five years old to get the benefit of the fertility of the soil. Ten acres of wheat yielded thirty bushels per acre at a profit of $27 per acre. This was irrigated two feet deep. Twentieth Century oats on twenty acres yielded in different years from seventy-five to eighty-six bushels per acre, and gave a profit of $30 per acre. This was irrigated two feet deep. The oats weighed twenty-three pounds per bushel. From one acre of Early Ohio potatoes, three hundred bushels were obtained, at a profit of $150. Twelve inches in depth of irrigation water was applied to these. Several kinds of berries were very successful but records of yield were not given. All of the crops named were reasonably certain in their results.

Another farmer with seventy-five acres in alfalfa obtained three tons per acre which he estimated gave a profit of $10 per acre. He would plow up alfalfa when from ten to fifteen years old. Twenty-five acres of wheat gave twenty bushels per acre at a profit of $10 to $12. One half acre of Early Rose, White Elephant and Gren Beauty potatoes yield at the rate of two hundred bushels per acre. . The profit is estimated to be between $75 and $100 per acre in growing potatoes.

Cody, Big Horn County.—Sixty acres of alfalfa reported from yielded two tons per acre and gave a profit of about $7. Six acres of wheat gave twenty-five bushels and about $25 profit per acre. Eleven acres of oats averaged forty-one bushels per acre.

One farmer reports alfalfa as the most valuable crop in Big Horn Basin. Another with one hundred acres in alfalfa

gave five tons per acre annually and makes $25 per acre. He would plow up the alfalfa when three years old. Soft wheat yields on the average from twenty-five to thirty bushels. Swedish Select and Lincoln oats yield fifty to sixty bushels per acre. Potatoes average two hundred bushels per acre. He irrigates his alfalfa twice for each crop, Lincoln oats two times during the season and the Swedish oats once.

Lusk, Converse County.—Twenty-five acres of alfalfa are reported to yield five tons per acre and a profit of $30. It is estimated four inches in depth was applied in the case of the twenty-five acres reported. Alfalfa plowed up when three to six years old. Native hay yields vary very much with soil and amount of water applied in irrigation. The native hay raised by one farmer is reported as being one hundred per cent "blue stem" or fine stem grass. Other crops raised were Macaroni wheat, Beardless barley, Kherson and Big White oats, Ohio Jr. potatoes and sugar beets. The last are fed to stock. Root crops and fruits are a success in this locality.

Laramie, Albany County.—One hundred acres of alfalfa are reported as averaging about two tons per acre, and is a very satisfactory crop. It is irrigated to a depth of one foot or more. It is found especially good for calves, colts, hogs and weak stock. It is recommended by one farmer that alfalfa be seeded on low lands and that it should not be irrigated too late in the fall. Native hay is also a good crop in this locality. One farmer reports nearly all native hay as "blue stem." Timothy is used with success as a mixture in native hay meadows. Wheat has been satisfactory but yield not reported. Barley makes a good yield and is a certain crop except for hail. It has been used for chicken feed with success. Russian or Side oats yields from forty to sixty bushels, does very well and is one of the most ueful crops for feed on the ranch. The Early Rose and Early Ohio potatoes are reported as doing well, if the frost does not come too

early in the fall. Root crops in general do fine and are a very sure crop. They are found useful for feed for hogs, calves, milk cows and for table use. It is claimed they keep very well during the whole winter.

Beaver, Converse County.—Twenty-five acres of alfalfa average three tons yield and $7.50 net profit per acre. It is a sure crop. It is irrigated to about six inches in depth and is plowed up when from twelve to fifteen years old. Seventy-five acres of native hay average one ton per acre. Maccaroni wheat yields thirty bushels per acre. Kherson wheat and Russian oats yield fifty bushels per acre. Early Ohio and Pearl potatoes average some two hundred bushels per acre.

Laborie, —Twenty-five acres of alfalfa yield four tons at a profit of $12 per acre. Alfalfa is plowed up when ten years old. Twenty acres of native hay average two and one-half tons per acre which gives a profit of $15. One half of this is estimated to be "blue stem." Five acres of oat hay and millet yield two tons per acre, but it is not a certain crop. Two and one-half acres of wheat were raised, but the crop was a failure. One and one-half acres of potatoes yielded at the rate of two hundred bushels per acre. One-half acre of field peas gave a yield at the rate of thirty bushels per acre. With the exception of the wheat and oat hay with millet, all of these are reasonably certain crops. Plenty of manure has been found to increase the yields and to hold moisture.

Saratoga, Carbon County.—Alfalfa is reported to yield from three to four tons in this locality. It is a sure crop and a most profitable hay crop. It is plowed up when ten to twenty years old and the yields on alfalfa ground are much increased. Wheat is fairly reliable, while Hulless barley, oats, potatoes, turnips, small fruits and berries, and rye are all reasonably certain in this locality. Oats has yielded as much as ninety bushels per acre.

Encampment, Carbon County.—Seventy-five acres of alfalfa reported to be very successful, but yield per acre not given. It is not plowed up until fifteen to twenty years old.

Widdowfield, Carbon County.—Alfalfa averaged two tons in two cuttings. It is a certain crop. One irrigation is applied during the season. Best results said to be obtained by plowing up the alfalfa when five years old. It is said to grow best when planted without a nurse-crop. Native hay said to average three-quarters of a ton in this locality. A yield and profit of about $3 per acre. With irrigation it is a sure crop. Beardless barley has yielded one hundred bushels per acre on well manured ground. Two hundred fifty to three hundred acres of oats grown in different years have yielded from thirty-five to forty-nine bushels per acre and it is a reasonably sure crop. Potatoes are fairly certain. Three-quarters acre of Early Rose potatoes yielded at the rate of two hundred bushels per acre. Currants are said to be reasonably certain in results. Any kind will grow.

Trelona, Laramie County.—Five acres of alfalfa irrigated heavily gave three crops and averaged over eight tons. Forty-one and one-third tons were raised on the five acres. Garden truck is raised and is said to do fine, very large vegetables being obtained.

Embar, Big Horn County.—While records have not been kept and the chief industry is stock raising, alfalfa has been found to be the most profitable crop. Next in order comes oats, potatoes and wheat.

Junction, Laramie County.—Fifty acres of alfalfa are reported to yield four tons per acre, at a profit of $10 per acre. Twelve inches in depth of irrigation water is applied. Alfalfa is plowed up when ten years old. Leaf-spot disease is becoming serious. Thirty acres of native hay average two tons per acre, yielding a profit of $8. Eighty per cent of this is estimated to be "blue stem." Two acres of wheat

gave twenty bushels per acre. Six inches of water applied. Two acres of Beardless barley yield about the same with the same amount of water used. Five acres of oats gave forty bushels, or $8 profit per acre. One-half acre of potatoes yielded at the rate of one hundred bushels per acre. Six inches irrigation water was applied.

Little Medicine, Albany County.—A small acreage of alfalfa in this locality is reported to average one and one-half tons per acre and to be an uncertain crop. It is usually plowed up when the alfalfa is from three to four years old.

Labonte, Converse County.—Two hundred acres of alfalfa are reported to yield two to four tons per acre, according to the soil and the season. It will average $10 per acre profit. Most of this is sixteen years old and is said to be as good as when six years old. Seventy-five acres of Scottish Chief and Russian White oats have yielded from forty-five to ninety bushels per acre in different years, and the oats have weighed from forty to fifty-four pounds per bushel.

Moore, Albany County.—Ten acres of alfalfa average four tons per acre. $38 gross profit per acre is obtained. Five acres of native hay yield two tons per acre; $5 gross profit per acre. Two acres of potatoes average two tons per acre and yield $80 gross profit. The varieties raised were the Ohio Netted Gem and Blue Victor. Apples have been raised successfully, Wealthy, Duchess, Greenings and Transparents doing especially well. Cabbage and caulifower are raised successfully and the profits are large.

Guernsey, Laramie County.—From ten to twenty acres of potatoes have been raised in different years. The Ohio Jr. has given a profit of $98 per acre and is a reliable crop. One acre of onions yielded $250. One acre of cabbage gave nearly as great returns.

Arcola, Laramie County.—One hundred twenty acres of alfalfa have averaged in several years one and one-half tons

per acre. Twenty acres of native hay have given about one ton per acre. Both of these are sure crops under irrigation. Thirty acres of oats for hay are raised and one and one-half tons per acre are obtained.

Mandel, Albany County.—Two acres of alfalfa have given two tons per acre and it is a sure crop. Native hay in this locality averages about one ton per acre. Oats, both Lincoln and Swedish Select, have given sixty bushels per acre on the average, and potatoes of the Early Rose variety have yielded from one hundred thirty-five to one hundred sixty-five bushels per acre. All vegetables that have been tried did very well. Wheat is reported not to do well. Barley does fairly well.

Thermopolis, Big Horn County.—Twenty-five acres in alfalfa average two tons per acre. With proper care it would give four tons per acre.

No comments on the above are given, because of the small number of replies received from several agricultural sections of the State. General conclusions are left to the reader of the above reports.

Report of the Librarian.

The general library of the University contains 24,000 volumes. This represents books in every department. Each department has its department library. The Experiment Station has a library in the offices of the Director, containing all books on agriculture and related subjects, bound bulletins and reports from the different experiment stations and Agricultural Colleges; the bulletins bound, issued by the Department of Agriculture, D. C., and many foreign publications.

An unusual effort has been made during the past year to obtain missing numbers of publications from the several experiment stations. These have been bound as volumes were completed and add materially to the usefulness of the Agricultural Library. Many periodicals are also placed on the files for the use of this department. The agricultural papers generally send their publications in exchange for the publications issued by this Station.

GRACE RAYMOND HEBARD,
Librarian.

Meteorological Summary for the Year 1907.

JAN. 1 TO DEC. 31.

The equipment for the meteorological work is the same as used in all Government stations. Except that the temperature has been slightly warmer and the precipitation slightly less, the weather conditions have been practically normal. The average temperature for the past 17 years was 40.7 degrees. The past year it was 41.9. The highest temperature for the year was 85 degrees, occurring on July 4th and 19th. The lowest temperature, —9, occurred on the 19th of December. The coldest month, as indicated by mean temperature, was December, with an average of 23.5, as compared with 22.4, the lowest mean during the past 17 years.

The average precipitation for the past 17 years is 10.03 inches; total precipitation this year, 9.46. The greatest precipitation within any 24 consecutive hours was 1.30 inches, on July 25th, while the month of July gave the maximum precipitation of 3.68. The snow fall of 15.15 inches was also a little less than normal.

The wind record has been about normal; prevailing direction southwest, which direction also gave the greatest amount of wind and the greatest velocity. Maximum velocity was 66 miles an hour, occurring March 21st; average velocity for the year, 13.2. The greatest amount of wind in any one month was 12,434 miles, in March, and the least, 7,519 miles, in October. There was the least wind from the northeast.

The percentage of sunshine was placed at 68, which is a little lower than normal, the total number of cloudy days being 55, partly cloudy 122, and clear 188.

Barometer readings averaged 23.013. The highest reading was 23.351, and the lowest 22.462.

Comparing the average temperatures of the years, it seems better to use the ground thermometers, which are not subject to sudden variations. Comparing the thermometer at 24 inches deep, we have an average temperature of 44.7 in 1906 and 45.4 in 1907. These records corroborate the conclusions mentioned at the beginning of the report, that the year has been slightly warmer than the average, and was a part of a degree warmer than the previous year.

EXPLANATION OF THE FOLLOWING TABLES.

The *terrestrial minimum* shows the lowest temperature at the ground, and may register a frost which will kill some vegetation, while the official record, taken six feet above, will indicate no frost.

The *dew point* is the temperature to which the air has to be reduced in order to precipitate the moisure.

The *vapor pressure* is the relative amount of water in the air, and depends upon the temperature.

The *solar radiation* is the effect the sun's rays have upon the surroundings, and is expressed in degrees.

In the table of precipitation T stand for *trace*, or less than .01 of precipitation.

Snowfall is measured with a yard stick in several places and the average taken. Ten per cent of snow is considered water.

FRANK A. SMITH,
Observer.

TEMPERATURE MEANS FOR 17 YEARS.

YEARS	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Highest	Lowest
1891	20.2	23.3	25.6	40.5	54.5	58.4	61.2	61.1	55.1	43.2	28.6	19.6	40.9	83	—13
1892	20.6	25.2	30.8	35.5	44.4	55.7	62.8	61.9	56.0	39.2	33.1	20.7	43.8	85	—29
1893	26.8	20.7	28.8	34.2	44.2	57.2	64.0	60.7	52.8	42.3	29.2	26.6	40.6	87	—9
1894	19.9	16.2	29.4	39.1	52.3	55.8	63.2	62.2	51.8	44.4	22.8	21.5	39.9	88	—27
1895	20.5	17.9	27.5	40.0	45.3	52.2	58.8	61.6	54.5	40.9	27.0	15.3	38.5	87	—30
1896	27.7	22.8	26.2	37.4	47.3	59.1	62.3	61.9	52.6	41.9	26.3	31.4	41.4	84	—27
1897	16.5	21.2	24.3	35.0	49.3	58.9	60.7	60.5	56.8	42.3	34.8	15.0	39.6	85	—30
1898	17.0	25.5	26.8	40.3	44.1	56.8	65.1	62.9	51.9	39.3	23.1	14.3	38.9	88	—23
1899	20.6	9.5	24.5	38.3	45.5	55.8	62.1	67.0	59.7	40.8	35.7	17.2	39.7	87	—40
1900	25.7	19.7	32.2	35.9	50.8	61.5	62.8	62.3	51.8	45.1	38.5	25.7	42.7	91	—27
1901	19.3	19.4	26.5	34.5	49.5	53.6	67.8	62.7	52.4	44.4	31.8	20.9	40.2	92	—23
1902	22.2	26.2	27.5	37.6	49.0	58.0	59.9	57.4	51.5	44.3	32.6	24.5	40.9	91	—18
1903	23.3	11.5	29.3	37.5	43.9	53.9	62.7	63.1	51.2	43.3	34.8	26.4	40.1	84	—8
1904	20.2	29.7	32.5	38.5	46.8	54.0	60.5	61.5	54.3	42.2	35.5	26.2	41.8	84	—16
1905	23.1	15.5	34.6	35.6	44.6	58.3	61.4	62.9	54.9	37.4	33.0	22.2	40.3	91	—42
1906	24.5	27.5	24.7	39.8	47.4	55.1	60.3	61.6	53.7	40.3	29.1	30.0	41.1	88	—19
1907	24.7	32.9	36.1	37.1	42.2	53.5	62.6	61.5	53.7	44.7	30.1	23.5	41.9	85	—9
Sum	372.8	364.7	487.3	636.8	801.1	957.8	1058.2	1052.8	914.7	716.0	526.0	381.0	692.3		
Means	21.9	21.5	28.7	37.5	47.1	56.3	62.2	61.9	53.8	42.1	30.9	22.4	40.7		

GROUND THERMOMETERS FOR 1906 AND 1907.

	1906						1907					
	6 in.	12 in.	18 in.	24 in.	36 in.	72 in.	6 in.	12 in.	18 in.	24 in.	36 in.	72 in.
January	25.8	25.2	24.4	27.0	27.5	36.6	28.4	28.5	28.5	30.7	32.6	38.9
February	29.9	28.1	27.4	28.8	30.3	35.7	32.7	31.4	31.0	31.1	32.3	37.2
March	31.9	31.1	30.2	30.9	31.9	35.6	39.6	38.0	35.5	34.4	34.5	37.1
April	47.1	45.5	41.8	39.7	38.2	37.8	48.8	47.1	44.1	42.3	41.3	40.4
May	57.1	55.0	48.5	48.0	46.1	42.8	50.1	48.6	46.0	44.3	43.2	42.8
June	67.3	65.3	58.3	56.5	53.8	48.1	65.2	62.3	58.0	53.9	51.2	46.7
July	72.8	71.1	66.0	62.0	59.0	53.1	73.0	70.6	66.0	62.3	59.0	52.7
August	75.1	71.6	66.7	63.4	61.7	56.2	72.4	70.7	66.4	63.1	61.2	55.7
September	63.7	60.2	59.0	58.6	57.8	56.5	63.8	62.5	59.3	58.7	57.8	55.8
October	47.6	48.1	47.5	49.0	50.0	52.5	51.6	51.2	49.5	50.5	51.2	52.7
November	34.9	36.1	36.8	38.8	40.8	46.5	35.5	36.5	36.5	39.9	41.2	44.7
December	29.9	30.2	31.0	33.8	35.3	42.0	28.0	29.3	30.2	33.3	36.0	42.9
Sum	583.1	567.5	537.6	536.5	532.4	543.4	589.1	586.7	551.0	544.5	541.5	547.6
Average	48.6	47.3	44.8	44.7	4.44	45.3	49.1	48.9	46.0	45.4	45.1	45.6
	45.85						46.52					

PRECIPITATION FOR 17 YEARS.

YEARS	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1891	0.70	0.38	1.50	0.25	2.92	0.91	1.20	1.76	1.80	0.30	1.09	1.11	13.92
1892	0.01	0.36	0.52	0.15	1.16	3.97	2.22	0.14	T	3.96	T	0.20	12.73
1893	T	0.11	0.29	0.32	0.33	0.54	0.34	1.08	0.39	0.28	0.06	0.10	3.84
1894	0.03	0.10	0.29	1.51	0.42	0.64	1.41	1.26	1.60	0.09	0.05	0.23	7.63
1895	0.08	0.14	0.43	0.87	2.09	2.12	2.71	1.17	0.18	0.74	0.32	0.33	11.15
1896	0.44	0.17	0.59	3.53	2.37	1.72	1.66	0.89	1.16	0.18	0.09	T	12.80
1897	0.39	0.35	4.23	0.55	1.85	0.72	1.29	1.11	0.32	0.55	0.33	0.77	12.48
1898	0.05	0.01	0.40	1.26	1.88	0.90	0.65	1.16	T	0.48	0.61	0.23	7.63
1899	0.95	1.13	1.11	1.75	0.37	1.11	2.01	1.43	0.17	1.13	0.07	0.61	11.84
1900	0.01	0.82	0.58	2.91	0.24	9.35	1.25	0.61	1.11	0.56	0.06	0.03	8.53
1901	0.04	0.41	0.05	0.28	3.00	1.73	0.32	1.11	0.09	1.28	T	0.21	8.52
1902	T	0.26	0.41	0.88	0.26	0.60	1.49	0.40	1.58	0.74	0.22	0.89	7.72
1903	0.11	0.36	1.09	0.73	1.63	1.00	1.31	0.88	2.37	0.54	0.30	0.07	10.37
1904	0.25	0.11	0.36	0.84	1.74	2.01	1.33	0.93	1.35	0.50	0.04	0.08	9.58
1905	0.39	0.42	0.64	1.21	1.79	0.36	1.79	0.83	1.62	0.46	0.22	0.03	9.76
1906	0.58	0.05	1.01	1.75	0.91	1.71	1.75	0.59	2.09	1.33	0.41	0.39	12.57
1907	0.29	0.15	0.28	0.78	1.09	0.90	3.68	1.28	0.62	0.16	T	0.23	9.46
Sum	4.32	5.33	13.78	19.61	24.05	21.29	26.41	16.63	16.47	13.28	3.87	5.51	1705.4
Means	.25	.31	.81	1.15	1.41	1.25	1.55	.98	.97	.78	.23	.32	10.03

WIND RECORD FROM JAN. 1, 1907, TO JAN. 1, 1908.

1907	North			N. East			East			S. East			South			S. West			West			N. West			Total
MONTHS	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles
January	330	45	55	147	19	15	137	20	15	761	65	15	1571	121	30	7312	353	10	925	73	35	646	45	05	11829
February	374	47	15	138	13	45	129	16	45	865	90	15	721	83	45	4707	272	45	1141	65	15	1220	82	15	9295
March	182	24	50	161	21	15	63	8	45	901	88	00	1386	109	45	7944	368	05	1025	59	30	772	63	50	12434
April	367	38	45	885	38	45	1191	67	10	1525	124	40	468	50	30	2826	156	35	1596	92	00	3135	151	35	11993
May	771	78	50	707	48	40	970	72	10	2165	182	50	822	84	30	1718	97	40	283	26	50	2738	152	30	10174
June	538	51	05	326	26	50	657	56	30	3058	180	15	671	89	40	2026	136	35	995	74	50	1156	104	15	9427
July	245	31	15	351	35	50	794	56	20	2669	221	00	799	116	45	1706	131	15	460	44	15	1201	107	20	8225
August	228	23	45	113	9	45	485	39	50	2418	207	20	1509	169	35	1954	142	40	1425	95	45	762	55	20	8894
September	149	18	30	137	12	40	653	51	45	1828	184	55	1052	119	20	2481	171	40	839	59	15	1432	101	55	8571
October	383	40	35	598	53	45	970	71	35	1564	156	00	1005	163	30	1396	111	10	528	42	25	1075	105	00	7519
November	365	47	30	50	9	05	434	48	25	975	118	35	610	73	25	3073	185	45	1389	109	25	1458	127	50	8354
December	1168	122	40	36	6	55	128	25	50	390	64	40	972	111	15	2823	199	40	1853	119	55	1455	93	05	8825
TOTAL	5100	570	55	3649	296	30	6611	535	20	19119	1683	45	11586	1293	30	39966	2327	00	12459	863	00	17050	1190	00	115540

NOTE—Average velocity, 13.2 miles per hour.

WIND RECORD, 1907.

Direction	Percentage in miles	Percentage in time	Greatest Velocity Record: Month	Direction	Gt. Velocity	Date
North	04.42	06.52	January	S. W.	54	4
N. East	03.16	03.38	February	S. W.	60	2
East	05.72	06.11	March	S. W.	66	21
S. East	16.59	19.22	April	N. W.	60	7
South	10.02	14.77	May	N. W.	48	26
S. West	34.56	26.57	June	S. E.	50	25
West	10.78	09.85	July	S. W.	60	14
N. West	14.75	13.58	August	W.	60	19
	100.00	100.00	September	N. W.	60	8
			October	N. E.	40	7
			November	S. W.	50	27
			December	N. W.	51	23

SUMMARY BY MONTHS FOR 1907.

MONTHS	Temperature: Maximum	Temperature: Date	Temperature: Minimum	Temperature: Date	Temperature: Means	Temperature: Average Terrestrial Minimum	Temperature: Mean Max.	Temperature: Mean Min.	Precipitation: Total	Precipitation: Greatest in 24 Hours	Precipitation: Date	Days: Clear	Days: Partly Clear	Days: Cloudy	Average Dew Point	Average Relative Humidity	Average Vapor Pressure	Per Cent of Sunshine	Snowfall Inches	Average Solar Radiation	Barometer Average
January	32	23	−6	15	25	12.1	37	13	.29	.27	15	15	13	2	17	72	.129	67	5.00	96	22.890
February	55	*11	1	3	33	18.7	45	21	.15	.07	2	13	11	4	20	68	.160	68	1.55	103	23.019
March	67	*19	2	13	36	20.9	48	25	.28	.15	9	12	15	4	22	65	.203	64	2.85	114	22.925
April	67	10	8	21	37	20.9	50	24	.78	.42	28	14	11	5	24	66	.216	68	2.75	116	22.830
May	73	*20	7	3	42	24.2	53	31	1.09	.26	29	7	10	14	33	75	.272	43	.50	121	22.973
June	78	29	31	1	53	. . .	68	39	.90	.22	6	16	12	2	40	60	.389	75	None	136	23.003
July	85	*4	41	*16	63	39.8	78	48	3.68	1.30	25	20	8	3	44	57	.296	74	None	147	23.155
August	84	24	34	11	61	38.5	76	47	1.28	.67	8	18	12	1	41	54	.267	71	None	144	23.149
September	80	4	24	20	54	30.5	69	38	.62	.17	*7	19	6	5	34	55	.196	70	None	132	23.122
October	75	5	20	20	45	18.5	60	28	.16	.11	5	21	7	3	27	59	.143	79	None	121	23.075
November	61	6	−7	11	30	8.9	45	15	T	T	0	20	8	2	13	59	.075	77	None	102	23.077
December	53	1	−9	19	24	6.5	36	11	.23	.10	27	12	9	10	11	60	.077	59	2.50	91	22.935
Sum	830	. .	146	. .	503	239.5	665	340	9.46	. .	. .	187	122	55	326	759	2.423	815	15.15	1423	276.153
Average	69.1	. .	12.2	. .	42	19.9	55.4	28.3	.79	. .	. .	. .	. .	.	25.5	63.2	.202	68	. .	119	23.013

*On more than one date.

THE UNIVERSITY OF WYOMING

AGRICULTURAL COLLEGE DEPARTMENT.

NINETEENTH ANNUAL REPORT

. . . OF THE . . .

U. S. Agricultural Experiment Station

. . . OF . . .

WYOMING

1908-1909

LARAMIE, WYOMING,
U. S. A.

WYOMING
Agricultural Experiment Station

UNIVERSITY OF WYOMING
LARAMIE.

Letter of Submittal

U. S. Agricultural Experiment Station,
University of Wyoming.

To the President of the University of Wyoming.

Sir:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating agricultural experiment stations, and the act of Congress approved March 16, 1906, known as the Adams Act, I have the honor herewith to submit the Nineteenth Annual Report of the U. S. Agricultural Experiment Station of Wyoming, for the fiscal year ending June 30, 1909.

J. D. Towar,
Director.

University of Wyoming, Laramie, Wyo.,
Nov. 30, 1909.

Letter of Transmittal

To the Honorable,
The Board of Trustees,
Of the University of Wyoming.

SIRS:—I have the honor to transmit herewith the Nineteenth Annual Report of the Director of the University of Wyoming Agricultural Experiment Station, for the fiscal year ending June 30, 1909.

CHAS. O. MERICA,
President.

UNIVERSITY OF WYOMING, LARAMIE, WYO.,
Nov. 30, 1909.

UNIVERSITY OF WYOMING,
OFFICE OF BOARD OF TRUSTEES,
LARAMIE, WYO., Dec. 1, 1909.

To His Excellency, Governor Bryant B. Brooks.

SIR:—In accordance with Chapter 51, Section 1, of the Session Laws of 1899, as President of the Board of Trustees of the University of Wyoming, I hereby submit to you that portion of the report of the Board of Trustees which refers to the Annual Report of the Director of the Agricultural Experiment Station and other members of the Station council, for the fiscal year ending June 30, 1909.

Respectfully submitted,
OTTO GRAMM,
President of Board of Trustees.

Table of Contents.

REPORT OF THE STATION STAFF (Continued):

Report of the Station Staff

Report of the Director

The work of the Wyoming Experiment Station during the past year has consisted largely in a continuation of the lines of work already undertaken, and the results of this work indicate material progress, with very little completion of any particular line. The peculiar conditions of soil, climate and environment due to the scanty rainfall and high elevation of the Experiment Station farms, have compelled the workers in Agronomy and Animal Husbandry, who are more or less new to the local conditions, to grope with considerable care in order to size up the various situations. An experimenter coming from the lower altitudes and humid climates to an elevation of 7,200 feet, where the seasons are necessarily short, the nights cold, and many of the conditions met with in soil and animal experimentation entirely new, must study with considerable care before he can outline intelligently any experimental work, and, once begun, must carry on his investigations somewhat blindly and with very little precedent or record of the experience of others to guide him. The unique character of everything met with here which governs the conduct of experimental work, has made it more or less difficult for the experimenters to outline and carry to completion any of the projects which they may have undertaken.

The departments of the Experiment Station which have in the past year been carrying on investigations in the Hatch fund are: Agronomy, Animal Husbandry, Irrigation, Chem-

istry and Botany, while under the Adams fund, a Department of Wool Investigations, which works in co-operation with the Animal Husbandman and the Chemist; the Department of Irrigation, which is also dependent on the Departments of Agronomy and Chemistry; the Veterinary Department, which works with the Department of Chemistry and Botany, and the Department of Chemistry alone. In the reports of the various heads of the departments which follow later will be found briefly stated the work of the several departments.

Experiment Station Staff.—During the past year we have been fortunate in retaining nearly all of the members of the staff who have been connected with the institution for one year or longer. As intimated in the last annual report, the Animal Husbandman resigned, leaving the institution on September 1st. His place was filled by the appointment of Mr. A. D. Faville, of the University of Wisconsin. Mr. Faville took up his work the first of September, and has displayed a very deep interest in all lines of animal husbandry work in his department. Prof. H. T. Nowell left the institution to go into private work, and his place was filled by the appointment of Prof. J. C. Fitterer, a graduate of the Ohio State University and also of the University of Colorado. Professor Fitterer's time has been divided the past year between the various experiment station projects and that of teaching in the University. Having charge of the irrigation and civil engineering courses, his time has been about equally divided between the University and the Experiment Station.

At the end of the year, Mr. F. A. Smith, who had been acting as Assistant Chemist and Meteorologist, retired from the institution. The work in the Chemistry Department is of so great importance and has multiplied to such an extent that the coming year it will be necessary to appoint a man who will devote his entire time to the Adams fund work. By such an arrangement the two lines of chemical investigation may be separated, so that one man will devote himself to Adams fund

investigations and possibly employ assistants, and another man may devote his entire time to the Hatch fund work. Thus a differentiation of these two lines of work may be perfected, which will allow clearly defining the projects that are to be conducted, as well as the duties of the various men.

Experiment Station Farms.—Two farms belonging to the University are operated by the Experiment Station—the one which was formerly the State Penitentiary farm has been termed the Stock Farm, and the other, on which the experimental work with field crops is carried on, is known as the Agronomy Farm. Owing to the lack of equipment and due very largely to the very badly poisoned condition of the Stock Farm, due to seepage of alkali, practically no farming operations have been carried on on this farm the past year. A small area has been plowed up and will be used for growing forage and soiling crops, while the larger portion of the land this year has been used for pasture only. If the drainage system which has been installed upon this land succeeds in ridding the soil of the alkali, there is every reason to hope that a large portion of this farm can be successfully cropped, and that much of the necessary feed for live stock which now has to be purchased at considerable expense may be grown on this farm. The farm is provided with irrigation water and irrigation ditches, so that it only requires the completion of the present plans to rid the land of alkali to provide the institution with a very valuable piece of property, and one which will contribute much to the success and economy of future experiments. The buildings on this farm were never designed for the purposes for which we wish to use them at the present time; therefore, a considerable amount of remodeling, tearing down and rebuilding will be necessary. With the appropriation made by the Legislature last winter a suitable horse barn will be constructed, providing ample and comfortable quarters for the horses to be kept at this place, as well as room

for carriages and implements, and suitable loft for the storage of hay and beans for feed. The plan in mind now contemplates providing a suitable room for stock judging which shall accommodate classes in the regular course, as well as short course students. In time plans can be perfected whereby the penitentiary building may be made more useful, but at present there being no funds available for this work, the building will be used for the dairy barn, for the storage of grain and for the wool scouring plant. Some definite plan, however, for remodeling this building will need to be decided upon, and after estimates have been carefully worked out, the necessary appropriation made to utilize this valuable building for a more useful purpose. With the present buildings and yards and with such improvements as may be made without great expense from time to time, fairly convenient and complete accommodations for the various pens of sheep can be secured. Something by way of proper buildings for hogs will be needed in the very near future. The building used at present for this purpose is neither convenient, comfortable nor sanitary, and it should very soon be displaced by something that combines all of these requirements, as well as serving as a model for others to copy.

The Agronomy Farm has been under the care of Mr. D. L. McMillan during the past year, and on every hand are evidences of improvement and rearrangement which indicates good judgment and thrift on the part of the foreman. A considerable quantity of new fence has been erected; irrigation ditches, gates, boxes and bridges have been constructed, and the experimental work has been put on a more permanent and scientific basis. The Experiment Station barn, which formerly occupied a position on the University campus, has been moved to this farm, and will be erected and used as a granary and general work shop for the inside work on seeds and implements. When the barn provided for by the last Legislature is erected on this farm, a fairly good equipment

for the carrying on of the experimental work and the care and preservation of crops and seeds will be established.

Wool Investigations.—This branch of research work, which comes entirely under the Adams fund projects, has been carried on along the same lines that were reported upon one year ago. The question of the variability and the breaking strain of wool is so great that, even after nearly two years of continuous work on the testing of fibers, no definite conclusions can be arrived at, nor can any rules be laid down for future guidance in this investigation. A large amount of data was collected for this purpose with a view of publishing a bulletin near the close of the present fiscal year, but the discoveries made at the end of this time proved that the data were not sufficiently complete to warrant putting the figures in bulletin form, and therefore another long period of trial, with thousands more of tests, will be carried on before the publication will be put before the public.

The Wool Specialist has taken rooms in the Federal building, which the Postoffice Department has assigned for agricultural investigations. The two rooms occupied by the Wool Specialist and one by the Veterinarian were set aside for the Agricultural College, and we are at the present time occupying these rooms. While this place answers fairly well our purposes at the present time, the real laboratory work demands conveniences that cannot be had in this building, such as could be supplied where gas and running water could be had, and suitable tables and sinks could be installed for doing some of the simpler chemical work. Furthermore, the location of these rooms so far distant from the other University buildings makes the situation rather inconvenient. It is hoped that in time a proper laboratory can be provided for this important branch of investigational work. Two additional lines of investigation have been added the past year: One is merely an expansion of the feeding and breeding experiment to test

the influence of wide and narrow rations upon the wool fiber, the other is an environment test, whereby a flock composed of five breeds, which represent the principal types of wool, are being kept in the state of Ohio, and a similar flock in the State of Wyoming. The plan is to keep these two flocks where they are for a period of two years, and then change them, bringing the Ohio sheep to Wyoming and taking the Wyoming sheep to Ohio, to note the effect of climate, feed and water on the character of the wool. This plan has already begun in the state of Ohio, and the Wyoming sheep will be brought together from within the State before the next shearing time. The sheep being kept in Ohio are in charge of Mr. L. B. Palmer, of Pataskala, while the Wyoming sheep are to be kept with our own flock.

All of the wool investigation work is practically of a pioneer nature, and thus far very few results have been obtained, owing to the fact that the efforts thus far expended have been more that of devising plans and methods than the reaching of definite results. The outlook for the department, however, is very promising, and we shall look forward to some interesting results in the course of time. Further details of the work of this department will be found in the report of the Wool Specialist.

Alkali Investigations.—The portion of the Experiment Station farm mentioned in the last report as being badly poisoned by alkali has passed one year under treatment by flooding and the washing out of alkali through the system of tile drains. The result of this work is very gratifying, as already there are prominent signs of much improvement in the condition of this land. The finer grasses which apparently were destroyed by the alkali and seepage water are rapidly returning, and all other vegetation on this field is taking on ranker and more promising growth. The report of this work will appear in due time in a bulletin issued jointly by the irrigation

and chemical departments. The work of collecting samples and a careful study of the water applied and the water removed from the field has been going on for the past twelve months, and the outlook is very promising. From appearances now, it looks as though this land would be reclaimed much more quickly than was originally hoped.

Publications.—During the year the regular publications of the institution consisted in the Eighteenth Annual Report of the Agricultural Experiment Station and four bulletins, as follows, the annual report consisting of 94 pages:

Bulletin 79, "Ration Experiments with Lambs"; Bulletin 80, "Dry Farming in Wyoming"; Bulletin 81, "Lamb Feeding," and Bulletin 82, "Soil Nitrogen." Bulletin 79 was a publication, the result of some experiments conducted by Mr. George E. Morton, and dealt largely with the feeding of lambs on the various rations composed largely of locally grown feeds. Bulletin 80 is a compilation of the dry farming records of the State by the Director of the Experiment Station, together with a precipitation map of the State, figures and drawings for which were furnished by the Weather Bureau. Bulletin 81 consisted in a brief report on a lamb feeding experiment whereby Indian corn, spelt and barley were compared in the feeding of lambs. The lambs employed in this experiment consisted one-half of the Rambouillet wether lambs from the Government Breeding Experiment, and one-half of native cross-bred lambs.

The soil nitrogen bulletin consisted in a compilation of the analyses of soils on the Experiment Station farm taken after the farm had been under experimental work for some twenty years. The effect of the various methods of cropping was studied in its influence upon the nitrogen content of the soil.

Ranchman's Reminder.—*The Reminder* is a monthly publication issued by the Agricultural College. The editorship of

this little magazine, after Mr. H. T. Nowell left the institution, fell largely to the Director's office. The magazine has been issued with regularity, and the articles included therein have usually been of a timely and more or less instructional nature. There is considerable demand for this publication, and it affords an excellent opportunity of placing before the public many short articles and reports on agricultural topics which could not be incorporated in the regular Experiment Station bulletins. The scope of this magazine is very largely local, and it seems to fill a place that could not well be supplied by any other form of publication.

Poultry Department.—What was said in the former report regarding the necessity and demand for a department to study the poultry industry as it relates to the Rocky Mountain district, is still as important as it appeared to be one year ago. If for nothing more than determining some of the possibilities of the industry and of imparting instruction to the students of the institution, a department of this kind should be installed. There will arise many important questions, some of which might properly come within the scope of the Adams fund project, and could be taken up in the Experiment Station work.

Co-operative Range Sheep Breeding Experiment.—This experiment in co-operation with the Bureau of Animal Industry of the U. S. Department of Agriculture was begun in the year 1906, when a flock of 75 ewes was purchased, and the breeding of these ewes to pure-bred, large-sized, well-wooled Rambouillet rams was begun. The object of the experiment is the development of a type of sheep which shall be hardy on the range, stand flocking in large numbers, shear a good fleece, be of fair size and have a good mutton form. Thus far the breeding has been confined to Rambouillets. The foundation stock, as well as the sires that have since been used, have all

been either pure-bred or nearly so. All of the ram lambs of the first year's experiment were discarded; twelve ewes from that year's product were added to the breeding stock, and the following year fifty-one ewe lambs were saved, and these, together with the ewes originally purchased, bring the number up to 310 at the close of the present year. A few of the ewes have died, so that the breeding flock now consists of approximately 300. During the past year the Bureau has reinforced the breeding stock by the addition of a pure-bred Rambouillet ram purchased from L. W. Shaw, of Pottersburg, Ohio; a pure-bred Delaine ram, purchased of A. T. Gamber, of Wakeman, Ohio; and an imported Rambouillet ram purchased from Col. George Truesdell, of Washington, D. C. With the exception of the Shaw ram, these sires are considerably smaller in size than anything that the Bureau has previously provided. The Gamber and Truesdell rams have an excellent fleece, but their size and weight are such that their progeny will probably not tend to increase the size and mutton form of the animals to be used for future experimental work.

By the conditions of the experiment, the Bureau furnishes all of the original stock, the Experiment Station employs men to range the sheep and attends to keeping the necessary records. The expenses of conducting the experiment are shared equally and the increase in the flock is divided equally between the Bureau and the Experiment Station. Of the second year's crop of lambs, nine young rams have been saved, and what are not needed for breeding purposes will probably be offered for sale to the public some time during the coming fall.

The experiment is making fair progress at the present time, although the percentage of lambs secured has not been quite up to our expectations. I wish at this point to express my thanks to the F. S. King Brothers Company for their keen interest in this undertaking, and our appreciation of their constant endeavor to make the experiment a success. They have been caring for the sheep ever since the experiment was

begun, and have been untiring in their endeavors to give us the very best possible service.

At the close of the present year our Animal Husbandman, Mr. A. D. Faville, made a suggestion to the Bureau, looking to a material change in the plan, or at least a departure from the present system of carrying on the experiment. I heartily approve of Professor Faville's recommendations, a copy of which was forwarded to the Bureau and is herewith inserted.

A Few Additional Points to Be Included in the Government Sheep Breeding Experiment.—In the buying of breeding stock, a practical Western sheepman shall be consulted and shall, if possible, form one of a committee of three to make such purchases. The other two members of this committee shall be composed of the representative of the U. S. Department of Agriculture and the representative of the Station at which the experiment is being conducted.

The utmost care shall be exercised in the mating and selecting of all ewes, and this committee of three shall, if possible, be present when such selections are made.

The experiment shall be broadened to include a test of the value of Down and long-wooled blood on Rambouillet stock in developing a range ewe. If possible, fifty good Merino ewes shall be mated with each of five or six rams, such as the Lincoln, Cotswold, Oxford, Romney Marsh, Leicester, Hampshire and Horned Dorset. The selection of the rams to be used in this test shall be left to the discretion of the committee. The ewes resulting from this cross shall be bred back to Rambouillet or some fine-wooled type. If it seems desirable, the ewes of the second cross shall again be bred back to fine-wooled rams. At least fifty good ewes shall be secured as the result of the final crosses. The wether lambs may be used to advantage in feeding tests to determine the value of different crosses for mutton production, and wool samples may also be secured from this class of stock. Careful records shall

be kept of the weights of all animals used in the experiment, the weights of all fleeces shall be kept, and tests made as to the quality of the wool. The experiment shall run at least six years, preferably longer, until reliable data can be obtained. Ewes shall be run and lambed on the range, though they may be brought in to breed.

The additional suggestions made in this outline, when approved by the Department of Agriculture and the station carrying on the experiment, shall be embodied in the original contract.

Polled Herefords.—By an arrangement made in the autumn of 1906, the Experiment Station loaned to J. M. Carey & Bro., of Careyhurst, a pure-bred polled Hereford bull to be bred to pure-bred Herefords on the Careyhurst ranch, on condition that the Experiment Station receive one-fourth of the progeny. The first year's division of calves from this experiment occurred in August, 1908, when the Experiment Station received eight calves, there being three polled animals in the eight. The contract continues for another year, and two more crops of calves are forthcoming. It is hoped that the product of this experiment may give us the foundation stock for a small herd of polled animals which will in time be a credit to the institution, and which may result in our developing the breed to such an extent as to bring it fairly and prominently before the public.

Farmers' Institutes.—This branch of the University Extension work naturally falls to the Agricultural College to conduct. During the past year the institutes seem to have gained a little in popularity, as a larger number of institutes were held and the attendance was very materially increased. During the year ending June 30th, institutes have been held in the following counties of the State: Laramie, Albany, Weston, Sheridan, Johnson, Big Horn, Fremont, Natrona and

Converse. A total of 71 sessions was held, with an attendance of 4,403, an average of 62 at a session.

The following table shows the date, location, number of sessions, total attendance, and the lecturers who took part in the various institutes. This movement is taking on a very fair interest in many localities. The attendance and interest at these institutes are the greatest in the more thickly settled portions, where actual farming and a more intensive system of farming is undertaken. This is more particularly true of those localities in the State where new settlements are being made. These people who have recently come to the State to make their home here seem the more desirous of getting what information they can on the various subjects in which their work makes them interested. It is interesting to note that for the most part the attendance was greater last year than in former years, and that the farmers' institute movement is receiving its fair share of attention.

It has not been possible yet to arouse sufficient interest in the counties of Carbon, Sweetwater and Uinta to carry on the institute work. However, encouraging reports have recently come from these counties, and it is expected that during the present year at least two of these counties will be visited with this work. In fact, arrangements have been quite fully completed for carrying on the work in Uinta County the coming year. The counties of Sweetwater and Carbon are so largely interested in sheep, there being practically none of the districts where the closer settlement has begun, and the bringing together of the residents of these counties in sufficient number to hold meetings has not been possible. It is hoped that throughout the State the movement may take on such a character as to be of interest to all, whether farmers or stockmen.

At several of the places where institutes were held during the past year, the proposition to hold a longer institute, or what might be termed a short course in agriculture, was of-

fered, and at Wheatland, Basin and Buffalo the offer was accepted. The proposition was that if twenty or more individuals would agree to attend a school of agriculture during the coming winter, arrangements would be made for carrying on such a school for a period of ten days. The three towns have pledged their students, and placed the arrangements for such schools in the hands of active and competent committees. It is expected to carry out this plan in these three localities, and hoped that other towns may take up the movement and apply for a further carrying on of the plan.

FARMERS' INSTITUTES—1909.

Date	Place	No. of Sessions	Total Attendance	Lecturers
1909				
Jan. 22, 23	Wheatland	5	314	McWethy, Dr. Cooke, Knight, Towar, Johnston.
Jan. 25	Manville	3	243	McWethy, Dr. Cooke, Towar.
Jan. 26	Lusk	2	98	McWethy, Dr. Cooke, Towar.
Jan. 27, 28	Douglas	2	138	Dr. Cooke, Dr. Prien, Faville, Towar.
Jan. 29, 30	Lander	5	134	Dr. Cooke, Dr. Prien, Faville, Towar.
Jan. 30	Shoshoni	4	.....	Dr. Cooke, Dr. Prien, Faville, Towar.
Feb. 1, 2	Thermopolis	5	244	Dr. Cooke, Dr. Prien, Faville, Towar.
Feb. 4	Casper	1	24	Faville, Towar, Prien.
Feb. 10	Pine Bluffs	2	94	Faville, Cooke and Towar.
Feb. 11	Luther	3	182	Faville, Cooke, Towar and Nelson.
Feb. 12	Carpenter	3	275	Cooke, Towar and Nelson.
Mar. 4, 5, 6	Basin	7	495	Faville, Stoner, Nowell, Towar.
Mar. 8, 9, 10	Cowley	6	750	Faville, Stoner, Nowell. Towar.
Mar. 9	Garland	1	30	Nowell, Stoner.
Mar. 10, 11, 12	Cody	7	288	Faville, Stoner, Nowell, Towar.
Mar. 13	Big Horn	2	255	Faville, Stoner, Towar.
Mar. 15, 16	Buffalo	8	696	Faville, Stoner, Towar, Buffum.
Mar. 18	Newcastle	4	119	Faville, Stoner, Towar.
Apr. 10	Bosler	1	75	Towar, McWethy, Fitterer, Nelson, Knight.
June 25	Cheyenne	2	39	Towar, McWethy, Fitterer, Nelson, Knight, Cooke.
		71	4403	

Financial Statement of the Treasurer

UNIVERSITY OF WYOMING.

AGRICULTURAL EXPERIMENT STATION

IN ACCOUNT WITH

THE UNITED STATES APPROPRIATION, 1908-1909.

DR.

To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ending June 30, 1909, under Acts of Congress approved March 2, 1887, and March 16, 1906—

Hatch Fund	$15,000.00
Adams Fund	11,000.00

CR.

	Hatch	Adams	
By Salaries	$ 6,190.00	$ 7,179.68	
Labor	1,496.35	408.00	
Publications	912.76	......	
Postage and stationery	295.11	42.85	
Freight and express	408.60	207.75	
Heat, light, water and power	705.78	111.84	
Chemical supplies	170.27	308.48	
Seeds, plants and sundry supplies	448.49	100.54	
Feeding stuffs	2,082.60	608.03	
Library	35.71	24.42	
Tools, implements and machinery	485.95	19.75	
Furniture and fixtures	159.51	53.80	
Scientific apparatus	196.75	856.80	
Live stock	388.00	494.70	
Traveling expenses	866.41	284.67	
Contingent expenses	15.00	......	
Buildings and land	142.71	298.69	
Total	$15,000.00	$11,000.00	$26,000.00

We, the undersigned, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1909; that we have found the same well kept

and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $26,000.00 and the corresponding disbursements $26,000.00, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887, and the act of Congress approved March 16, 1906.

(Signed)

OTTO GRAMM,
V. J. TIDBALL,
A. C. JONES.

Attest:

FRANK SUMNER BURRAGE,
(Seal) Custodian of Seal.

SUPPLEMENTARY STATEMENT.

DR.

	Farm Products	Total
To balance on hand	$ 320.55	
Receipts from other sources than the United States for the year ended June 30, 1909	2,332.40	$2,652.95

CR.

By Labor	$ 111.24	
Freight and express	62.65	
Seeds, plants and sundry supplies	263.25	
Feeding stuffs	988.65	
Tools, implements and machinery	29.15	
Furniture and fixtures	3.75	
Live stock	69.00	
Traveling expenses	24.70	
Buildings and land	23.10	
Balance	1,077.46	
	$2,652.95	$2,652.95

Report of the Animal Husbandman

A. D. FAVILLE.

Changes have been too common in the Animal Husbandry Department, the Animal Husbandman and both of his assistants having come to the institution within the past year. This breaking in of new material has necessarily taken time and detracted from results obtained.

Mr. McLay, who occupies the position of farm foreman and shepherd, is a man of wide practical experience, and came to us most highly recommended. Mr. Berry is a short-course man from Fort Collins, and has also seen the practical side of stock problems.

During the past year, experimental feeding was confined to work with lambs; corn, barley and spelt being compared when fed with alfalfa as a basal ration. The object of the test was to compare Wyoming grown grains with corn for stock feeding. Results were published in Bulletin 81.

Farm buildings and grounds have undergone no extensive improvements during the past twelve months, though necessary repairs and slight alterations have been made. Electric lights have been installed in three of the buildings.

Plans for the new horse barn to be erected during the coming summer are rapidly nearing completion. This barn is to be provided with a much needed room which may be used for stock judging purposes. Detailed plans of the building will probably appear in a future report.

New stock is to be found in all departments, and much of the old is missing. Only superior animals should be used for class-room work, and breeding classes should be kept at the same high standard, if desired results are to be obtained.

Three new horses have been added, two of the general purpose type and one driver.

A Holstein Friesian cow is the only acquisition in the cattle classes.

Duroc Jersey and Berkshire boars and a Berkshire sow are listed in the new arrivals at the swinery.

The most extensive purchases have been made in the sheep department. Breeding classes have been greatly strengthened, and creditable exhibits can now be made at the leading stock shows. The Wyoming Station should be well represented at gatherings of this kind, as they greatly stimulate stock interests and serve as the best of advertising mediums.

The Government sheep breeding work is being carried forward along lines outlined in last year's report. Several additional rams have been purchased from the flocks of Eastern breeders. A movement is on foot to enlarge the scope of the experiment to include work in cross-breeding. An answer to the question, "Would a small infusion of 'Down' and long-wooled blood in Merino stock produce a more desirable type of range ewe?" is demanded by many breeders.

Experimental plans for the coming year include a continuation of this year's lamb feeding work; a test of the value of standard and narrow rations in beef and mutton production; trials to determine the value of Wyoming grains for swine, and digestion work to be carried on in co-operation with the Chemistry Department.

Special problems will be dealt with as they arise.

Report of the Wool Specialist

J. A. HILL.

The work of the Wool Department for the past two years has been confined principally to two lines. The first is the study of the variability of the breaking strain of wool fiber, and the second is the testing of wool shrinkage for the sheep owners of Wyoming. The causes which led to the study of the variability of the breaking strain have been set forth in the annual report of last year, together with a detailed explanation of the manner in which the study is being undertaken. The work has been continued as outlined in that report, except that it has been found necessary to make tests on a much larger number of samples than was contemplated at that time. It is planned to have this study completed and the results ready for publication within the next six or eight months.

In 1908, seventeen firms sent in a total of 2,746 pounds of wool to be scoured for the purpose of testing its shrinkage. The greater part of the scoured product was sold by the University, and the proceeds returned to the owners. The price received, when reduced to a grease basis, represented a considerable gain over the selling price of wool in Laramie during the season of 1908.

In April of this year a circular letter was again sent to the sheepmen of Wyoming, offering them the privilege of having the shrinkage of their wool tested free. Up to the date of this report, there has been no apparent gain in the interest which they take in this work which the Experiment Station is doing for them, and unless within the next year there is a marked change in their attitude toward this work, which was planned for their benefit, it should be discontinued.

A carefully prepared plan of the work to be undertaken under the Adams fund by the Wool Department has been submitted to the Office of Experiment Stations at Washington, D. C. The following is a brief outline of the plan as accepted:

PRELIMINARY WORK.

I. Study of the variability of the wool fiber in
  (a) Size.
  (b) Strength.
  (c) Elasticity.

II. Testing Methods.
  (a) To determine the number of fibers that it is necessary to test in order to give a good average of the tensile strength and elasticity of a sample of wool.
  (b) To determine the probable error of the mean of a number of fibers.
  (c) To determine relation between cross-section, elasticity and breaking strain.

REGULAR INVESTIGATION..

I. Study of the causes of changes in character of wool fiber from the normal.
  (a) Effects of sheep dips.
  (b) Hydroscopic water in wool and its relation to strength and elasticity of the fiber.
  (c) Effect of environment of the animal.
    1. Climate.
    2. Soil.
    3. Food.
    4. Water.
    5. General care.
  (d) Shrinkage of wool with relation to general character of wool fiber.
  (e) Breeds and effects of cross-breeding.

II. Laws governing hydroscopic water in wool with relation to the humidity of the atmosphere.

Arrangements should be made for an assistant in the Wool Investigations. This, together with the purchase of another fiber-testing machine, will greatly increase the speed at which the work of this department can be pushed forward.

Report of the Veterinarian

O. L. PRIEN.

The Experiment Station work of this department lies along the following four chief lines;

1. Research.
2. Practical veterinary service.
3. Bacteriological examination of specimens sent in for investigation.
4. Correspondence with the stockmen of the State covering the health of their stock.

This last portion of the work has been greatly checked by the previous lack of laboratory facilities, but its gradual increase in volume is an indication of its value in the general instruction of the stock owners regarding the care and management of their stock for the prevention of losses through disease.

Institute Work.—The Veterinarian of necessity takes an active part in the educational work of farmers' institutes in a State whose live stock interests represent an investment of almost eighteen millions of dollars. The instruction given has been by way of lectures on both the common non-contagious conditions liable to be met with, together with their treatment and correction, and upon the infectious diseases of the West and their prevention.

Laboratory work.—Up to the present time all laboratory work done has been carried on without equipment. A little more work needs to be done by way of fittings before the laboratory is sufficiently appointed to allow of any work of

a bacteriological nature to be undertaken. All apparatus necessary has been ordered and received, so that no delay will be encountered from this feature.

The work embraced by the laboratory will include not only minor examinations of material sent in at large, but will probably be co-operative with the various organized stock boards and the Pure Food Commission for the purpose of minimizing the losses from epizootic diseases and lessening the danger of human infection by consumption of diseased or disease-carrying products.

This being only one portion of the work of this department, it is requested that a student assistant be allowed who can take care of much of the detail of the work, thus permitting more time for attendance to other duties.

Practical Veterinary Service.—Practical service has been rendered the Station in the matter of attention to the health of its stock and suggestions concerning its care and management. During the past year some eighty cases have been treated, of which two terminated fatally, both among sheep. No cases of especial interest occurred. Another feature of this work is that of passing upon horses purchased by the Animal Husbandman for soundness, a matter of importance, especially in the consideration of hereditary unsoundnesses.

Research.—Plans for research work in the field of vegetable poisons have been outlined and accepted by the Department at Washington, D. C. This work is co-operative with the Chemist, and to some extent with the Botanist, who has proffered his services whenever they may be required.

Some preliminary field work has been done in connection with the Woody Aster (*Xylorrhiza Parryi*), to the consumption of which large losses among sheep are ascribed.

The time when this work must, in a great part, be carried on is in the early spring, when it is virtually impossible for

the Veterinarian to leave many of his other duties. It is therefore requested that an assistant be obtained to aid in the necessary field work by answering the calls, making field observations, autopsies and carrying out the field experimentation, thus allowing a greater amount of unbroken time for the laboratory work and attention to other duties.

Report of Agronomist

L. B. MCWETHY.

The work at the Agronomy Farm for the past year was subject to some misfortunes that will necessarily make this report brief and largely explanatory in its nature. During the season of 1908 there were being carried on variety tests with oats, barley, field pease, root crops, potatoes and alfalfa; a test of fall and spring plowing as to its effect on various crops; the comparative use of nitrate of soda as a preliminary to the study of the nitrogen problem, and a beginning was made for the study of the laws that apply to the selection and breeding of plants.

The unusual weather conditions of the growing season rendered crop production so abnormal that comparative results were impossible. The early growth of plants was retarded by cool weather, a freeze in June and another on the 2d of July; on July 18th a hail storm swept vegetation level to the ground. During the succeeding six weeks, everything made a remarkable recovery and again gave evidence of good returns. On August 31st a killing frost made maturity of the crops an impossibility. Grain crops were cut for hay, and the root crops were scarcely worth the labor of harvesting. On a few plots some data were secured by measurement of the yields of grain hay.

For the season of 1909 the same lines of work attempted in 1908 were in general continued. In addition, a series of experiments have been undertaken to study the factors of influence in the cultivation of small grains during their early growing period, this being duplicated under varying conditions.

Some investigations with grasses have been undertaken, to study a few leading species as to their adaptability and merit under irrigated conditions. The Diamond Cattle Company at Rock River has kindly lent its co-operation in this work, so that it is being duplicated on larger areas under conditions such as exist on the average ranch.

An area of land above the Pioneer Canal had been plowed during the summer of 1908. The Experiment Station was given the use of about 25 acres for a preliminary trial of the possibilities of dry farming. This was sown to various grains, and is now showing excellent prospects for a profitable crop. The area is being used for some comparative tests of the value of harrowing small grains.

Last year, twenty-one quarter-acre plots were established for the purpose of conducting soil fertility experiments. The area was planted to potatoes to test the plots for uniform production before attempting any experiments. At harvest time so much irregularity was exhibited that the series was sown to barley this year to again test the plots for uniform production.

The irrigating of the crops and general supervision of the farm work has been in charge of Mr. D. L. McMillan. His efficient services have been an important factor in the operation of the farm.

Report of Agricultural Chemists

H. G. KNIGHT, F. E. HEPNER AND F. A. SMITH.

During the past year the work along two new lines has been taken up. Both of these were under the Adams Act. It is not possible, under the circumstances, to continue the lines of work which have been followed here for several years, for the fact that we do not have aid enough to carry on all of the work outlined. We realized at the beginning of the year that if we took up the new lines of work under the Adams Act, it would be practically impossible to publish any bulletins from this department for the year 1908-09, and that probably nothing could be published until the latter part of 1909-10.

We have fully realized that the close attention which must be given to work outlined under the Adams Act makes it practically impossible for a man who is working under this act to give much thought and attention to such work as may be called for which is covered by other funds. This being the case, I recommend that a chemist be employed, to be paid out of the Adams fund, to take up investigations outlined under this act. As this work requires a well trained man, I would advise that a sufficient sum be appropriated for his salary for the coming year. I believe that, for a moderate salary, we can get an experienced man, for the fact that opportunities for advancement are excellent. He should be released from routine work which may be necessary around the laboratory, and I recommend that funds be appropriated for this purpose also.

With the addition of a new man to the department (as at present we have no laboratory in which he may conduct his work), I recommend that money be appropriated for dividing the quantitative laboratory and for fitting up a research laboratory in the east end. The estimated cost is $350.

The appropriations from the Hatch fund should be approximately the same as they were last year, while, as we intend to increase the work under the Adams Act, the appropriations should be somewhat larger.

The work taken up during the past year was outlined under the following heads:

I. Wool Investigations.
II. Alkali Investigations.
III. Soil Moisture Investigations.

All of these are under the Adams Act.

The wool investigations have been carried on continuously throughout the past year to determine the cause of the weakness or strength of fiber of Wyoming wools. It is hoped to have some results during the coming year, but possibly not enough to warrant publication.

The alkali investigations were taken up in conjunction with the reclamation experiments carried on at the Stock Farm. Something over one thousand analyses have been completed, and we have been watching with interest the change of content of alkali by washing it into drains with irrigation water. There is a marked change in the one year during which the experiment has been carried on, which shows that any land which is inclined to be gravelly, by the use of tile drains and a copious supply of irrigation water, alkali may be washed out in a reasonably short time. This work is still in progress, but it is hoped to finish it up during the coming year.

About fifteen hundred analyses of soils for moisture were completed during the summer and fall of 1908, and between five and six hundred during the spring of 1909 up to the close of the year.

We are very much in need of more room in which to carry on our work. Even with the improvements which are in contemplation, we will be very much crowded. It is practically impossible to take on more work or even do the work

which is outlined for the present, as it should be done, unless some arrangement is made to supply more laboratories.

PLANS FOR FUTURE WORK.

Adams Act.

I. Soil moisture investigations. (In co-operation with Irrigation Engineer.)

II. Alkali investigations. (Probably in co-operation with the Engineer.)

III. Wool investigations. (A portion of this work is to be carried on in co-operation with the Wool Expert.)

IV. Investigation of poisons in one or two of our Wyoming forage plants and an attempt to work out antidote. (A portion of this work is to be taken up in co-operation with the Veterinarian.)

Hatch Act.

I. Digestion investigations. (In co-operation with the Animal Husbandman.)

II. Forage plant investigations. (In co-operation with the Botanist.)

III. The effect of soil constituents upon the composition of plants. (In co-operation with the Agronomist.) This has not been fully outlined as yet, but will be as the work is taken up. During the following year we shall probably take up this subject, studying the effect of various nitrogen contents upon the composition of plants.

IV. Alkali investigations. (A portion of the preliminary work upon alkali outlined under the Adams Act must be carried on under the Hatch Act.)

V. Some work will probably be outlined to be carried on in co-operation with the Animal Husbandman, a portion of which may come under the Adams Act. This has not been planned satisfactorily as yet. It will probably take up some phase of digestion work.

Report of the Irrigation Engineer

J. C. FITTERER.

The Experiment Station work of the Irrigation Engineer for the year 1909 consisted in carrying on the following lines of experiment and investigation in co-operation with the various departments closely allied and interested therein, viz.:

AT LARAMIE.

Agronomy Farm.—Acre and quarter-acre plats were laid out in Field B upon which various root crops and the hardier varieties of grains were grown. Irrigation experiments were carried on in this portion of the farm to ascertain the best treatment for raising feeding grains and roots, since the same, together with alfalfa, promise to best serve the stock ranchman's needs for provender. This is apparently becoming more and more important as the various portions of the State are being rapidly divided into smaller tracts of private holdings, and the public range correspondingly constricted. The year proved to be rather favorable, barring a late spring, and it is hoped to give some helpful, practical results for the benefit of the ranchmen of our State.

Additional irrigation experiments were conducted in the securing of new stands of alfalfa, the growth of potatoes, oats, etc., on other plats of the farm.

A topographic survey of the farm was undertaken, as well as a land survey of the same, the results of which are embodied in a large map of this portion of the Station's acreage.

A new iron headgate, with sewer pipe outlet through the bank of the Pioneer Canal, was installed before the irrigation

season opened, and removed the troublesome feature of leakage heretofore encountered with the old wooden gate.

Two continuous weir registers were installed at both farm headgates and graphic records thus obtained, supplemented by rule measurements to serve as checks.

Stock Farm.—Periodic measurements of water levels in the tile wells dug the preceding year were made throughout the summer season, as well as weir readings by rule and automatic water registers. Two of the latter were placed in position, one at the farm division weir and the other at the tile drain outlet near the west bank of the Laramie River. This work was performed as a part of the co-operative scheme outlined for the alkali drainage investigation carried on to reclaim the water logged land on this farm. The results are giving evidence of the complete restoration of the tract afflicted. No crop irrigation was called for, as the land available was all devoted to the grazing of stock.

A topographic survey of the half section included in the stock farm will be carried on during the summer vacation.

SOIL MOISTURE INVESTIGATIONS AT CHEYENNE.

In co-operation with the Bureau of Irrigation Investigations, 51 soil moisture samples are being taken every Saturday, and this will be continued during the growing season on various plats of the government experiment farm about one mile east of Cheyenne. These soil samples are conveyed to the University of Wyoming and the moisture content there determined and recorded. The plats were chosen with the aim in view of observing the behavior of soil moisture under different methods of irrigation and summer fallow, and under the action of different crops. It is hoped these determinations may be soon co-ordinated with the special related results obtained by the above mentioned bureau, and whatever valuable information is thus deduced placed in a form available for general use.

Report of the Librarian

GRACE RAYMOND HEBARD.

The libraries of the several departments of the Experiment Station have received during the year many valuable additions. The general library of the University contains 26,000 volumes and is placed at the disposal of the Experiment Station workers. All books bearing directly on the work being performed by the individual members of the Station are placed in the offices and laboratories where they may be most easily consulted. In the Director's office are placed all of the reports and bulletins from all of the states and from the departments at Washington. These in themselves make quite a respectable sized library. Every effort is being made to complete the files of the Agricultural Department of the University. The bulletins and reports are being bound as rapidly as the volumes are completed. Periodicals of this department are also bound and placed on the shelves of the department libraries, in fact this class of literature has proved to be of great value for reference work.

The publishers of the agricultural papers in all parts of the United States have been most generous in donating their publications to the University library. Very often these are sent in exchange for our bulletins, reports and other publications. There are a number of foreign publications on agriculture and allied subjects that regularly come to the station. The Agricultural Department library has the largest number of volumes of any department of the University.

Meteorlogical Summary for the Year 1908

JANUARY 1ST TO DECEMBER 31ST.

The records of temperature, precipitation, wind velocity, and atmospheric conditions which guide in the climatological studies given herewith are recorded in accordance with the regulations of the governmental meteorological stations. A comparison of the past year's records with those of former years shows a very uniform condition of temperature, a slight increase in precipitation, and a slight decrease in the amount of wind. The special weather conditions of the year are the particularly cold, late spring, as indicated by a temperature of 17 degrees on the 19th of May and an exceptionally early frost occurring on the 31st of August. The cold autumn is further marked by the lowest temperature of the season, occurring November 14th, when the temperature was 24 below. A study of the former records reveals the fact that all of the weather conditions mentioned above are of an extraordinary nature, as was a severe hailstorm which caused some damage on the 18th day of July.

The average temperature for the year has been but a fraction of a degree below the mean for the previous 17 years. The highest temperature for the year was 86 degrees, occurring on the 9th of August, and the lowest was 24 below on the 14th of November. July is the warmest month, with a maximum of 84 degrees, and an average of 61.4, while January, with an average of 19.75, was the coldest month of the year. The average of the ground thermometers shows 46.2, being slightly less than in 1907 and just about the average for the past three years.

A total of 13.53 inches precipitation for the year is 3.5 inches more than the average for the previous 17 years and sufficient to increase the general average for 18 years by .19

of an inch. The peculiarity of this excessive rainfall is the exceedingly light precipitation during the fall of 1907, and the first four months of 1908, when the total precipitation was 1.07 inches. According to the records, it will be found that this winter season was the driest seven months in the history of the meteorological records, the average for this period being 3.74. This period of drought was followed by abundant rains which came during the growing season and gave even better than normal growth of native pastures and such crops as are dependent on natural precipitation. The snowfall of 28.25 inches, one-half of which coming in the month of May, was considerably more than the average.

A review and summary of the wind record for the year shows a slight decrease in amount of wind, with an average of 12.77 miles per hour for the year, the prevailing direction in point of amount of wind being from the southwest, while in point of time the south winds prevailed the longest, there being, however, but slight difference between the quantity of wind and length of time consumed between the southeast, south and southwest breezes. March, May, January, and April in the order mentioned were the windiest months of the year. The maximum velocity occurred during the southeast snowstorm of May 9th. However, with all the rain, snow, and wind, the record shows over 72% of sunshine for the entire year, being something more than the average. There was a total of 204 clear days, 115 partly cloudy, and 47 cloudy days.

EXPLANATION OF THE FOLLOWING TABLES.

The *terrestrial minimum* shows the lowest temperature at the ground, and may register a frost which will kill some vegetation, while the official record, taken six feet above, will indicate no frost.

The *dew point* is the temperature to which the air has to be reduced in order to precipitate the moisture.

The *vapor pressure* is the relative amount of water in the air, and depends upon the temperature.

The *solar radiation* is the effect the sun's rays have upon the surroundings, and is expressed in degrees.

In the table of precipitation T stands for *trace*, or less than .01 of precipitation.

Snowfall is measured with a yard stick in several places and the average taken. Ten per cent of snow is considered water.

A. E. BELLIS,
Observer.

TEMPERATURE MEANS FOR 18 YEARS.

YEARS	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Highest	Lowest
1891	20.2	23.3	25.6	40.5	54.5	58.4	61.2	61.1	55.1	43.2	28.6	19.6	40.9	83	—13
1892	20.6	25.2	30.8	35.5	44.4	55.7	62.8	61.9	56.0	39.2	33.1	20.7	43.8	85	—29
1893	26.8	20.7	28.8	34.2	44.2	57.2	64.0	60.7	52.8	42.3	29.2	26.6	40.6	87	—9
1894	19.9	16.2	29.4	39.1	52.3	55.8	63.2	62.2	51.8	44.4	22.8	21.5	39.9	88	—27
1895	20.5	17.9	27.5	40.0	45.3	52.2	58.8	61.6	54.5	40.9	27.0	15.3	38.5	87	—30
1896	27.7	22.8	26.2	37.4	47.3	59.1	62.3	61.9	52.6	41.9	26.3	31.4	41.4	84	—27
1897	16.5	21.2	24.3	35.0	49.3	58.9	60.7	60.5	56.8	42.3	34.8	15.0	39.6	85	—30
1898	17.0	25.5	26.8	40.3	44.1	56.8	65.1	62.9	51.9	39.3	23.1	14.3	38.9	88	—23
1899	20.6	9.5	24.5	38.3	45.5	55.8	62.1	67.0	59.7	40.8	35.7	17.2	39.7	87	—40
1900	25.7	19.7	32.2	35.9	50.8	61.5	62.8	62.3	51.8	45.1	38.5	25.7	42.7	91	—27
1901	19.3	19.4	26.5	34.5	49.5	53.6	67.8	63.7	52.4	44.4	31.8	20.9	40.2	92	—23
1902	22.2	26.2	27.5	37.6	49.0	58.0	59.9	57.4	51.5	44.3	32.6	24.5	40.9	91	—18
1903	23.3	11.5	29.3	37.5	43.9	53.9	62.7	63.1	51.2	43.3	34.8	26.4	40.1	84	—8
1904	20.2	29.7	32.5	38.5	46.8	54.0	60.5	61.5	54.3	42.2	35.5	26.2	41.8	84	—16
1905	23.1	15.5	34.6	35.6	44.6	58.3	61.4	62.9	54.9	37.4	33.0	22.2	40.3	91	—42
1906	24.5	27.5	24.7	39.8	47.4	55.1	60.3	61.6	53.7	40.8	29.1	30.0	41.1	88	—19
1907	24.7	32.9	36.1	37.1	42.2	53.5	62.6	61.5	53.7	44.7	30.1	23.5	41.9	85	—9
1908	19.75	24.5	33.8	41.8	44.6	54.4	61.4	60.3	54.9	39.5	25.5	23.3	40.3	86	—24
Sum	392.6	389.2	521.1	678.6	845.7	1012.2	1119.6	1113.1	969.6	755.5	531.5	404.3	732.6		
Means	21.8	21.6	29.	37.7	47.	56.2	62.2	61.8	53.9	42.	30.6	22.5	40.7		

GROUND THERMOMETERS FOR 1906, 1907 AND 1908.

	1906						1907						1908					
	6 in.	12 in.	18 in.	24 in.	36 in.	72 in.	6 in.	12 in.	18 in.	24 in.	36 in.	72 in	3 in.	6 in.	12 in.	24 in.	36 in.	72 in.
January	25.8	25.2	24.4	27.0	27.5	36.6	28.4	28.5	28.5	30.7	32.6	38.9	26.2	25.5	26.1	28.5	31.8	38.7
February	29.9	28.1	27.4	28.8	30.3	35.7	32.7	31.4	31.0	31.1	32.3	37.2	30.4	28.3	27.4	28.8	31.0	36.5
March	31.9	31.1	30.2	30.9	31.9	35.6	39.6	38.0	35.5	34.4	34.5	37.1	41.6	39.3	35.8	34.1	35.1	36.8
April	47.1	45.5	41.8	39.7	38.2	37.8	48.8	47.1	44.1	42.3	41.3	40.4	50.9	49.8	45.3	43.0	41.7	40.7
May	57.1	55.0	48.5	48.0	46.1	42.8	50.1	48.6	46.0	44.3	43.2	42.8	52.0	50.8	48.0	45.8	44.6	43.3
June	67.3	65.3	58.3	56.5	53.8	48.1	65.2	62.3	58.0	53.9	51.2	46.7	64.3	64.6	59.5	55.0	52.3	45.5
July	72.8	71.1	66.0	62.0	59.0	53.1	73.0	70.6	66.0	62.3	59.0	52.7	72.6	71.5	66.2	62.6	59.7	53.6
August	75.1	71.6	66.7	63.4	61.7	56.2	72.4	70.7	66.4	63.1	61.2	55.7	69.8	69.7	65.3	62.3	60.5	62.7
September	63.7	60.2	59.0	58.6	57.8	56.5	63.8	62.5	59.3	58.7	57.8	55.8	66.2	44.4	61.4	49.9	58.8	55.9
October	47.6	48.1	47.5	49.0	50.0	52.5	51.6	51.2	49.5	50.5	51.2	52.7	46.1	46.6	46.1	48.2	49.6	52.9
November	34.9	36.1	36.8	38.8	40.8	46.5	35.5	36.5	36.5	39.9	41.2	44.7	33.2	36.2	32.2	38.7	70.5	46.8
December	29.9	30.2	31.0	33.8	35.3	42.0	28.0	29.3	30.2	33.3	36.0	42.9	24.6	27.4	28.4	31.1	34.7	41.9
Sum	583.1	567.5	537.6	536.5	532.4	543.4	589.1	586.7	551.0	544.5	541.5	547.6	577.9	554.1	541.7	528.0	570.3	555.3
Average	48.6	47.3	44.8	44.7	44.4	45.3	49.1	48.9	46.0	45.4	45.1	45.6	48.2	46.2	45.1	44.0	47.5	46.2
	45.85						46.52						46.2					

PRECIPITATION FOR 18 YEARS.

YEARS	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1891	0.70	0.38	1.50	0.25	2.92	0.91	1.20	1.76	1.80	0.30	1.09	1.11	13.92
1892	0.01	0.36	0.52	0.19	1.16	3.97	2.22	0.14	T	3.06	T	0.20	12.73
1893	T	0.11	0.29	0.32	0.33	0.54	0.34	1.08	0.39	0.28	0.06	0.10	3.84
1894	0.03	0.10	0.29	1.51	0.42	0.64	1.41	1.26	1.60	0.09	0.05	0.23	7.63
1895	0.08	0.14	0.43	0.87	2.09	2.12	2.71	1.17	0.18	0.74	0.32	0.33	11.15
1896	0.44	0.17	0.59	3.53	2.37	1.72	1.66	0.89	1.16	0.18	0.09	T	12.80
1897	0.39	0.35	4.23	0.55	1.85	0.72	1.29	1.11	0.32	0.55	0.33	0.77	12.48
1898	0.05	0.01	0.40	1.26	1.88	0.90	0.65	1.16	T	0.48	0.61	0.23	7.63
1899	0.95	1.13	1.11	1.75	0.37	1.11	2.01	1.43	0.17	1.13	0.07	0.61	11.84
1900	0.01	0.82	0.58	2.91	0.24	9.35	1.25	0.61	1.11	0.56	0.06	0.03	8.53
1901	0.04	0.41	0.05	0.28	3.00	1.73	0.32	1.11	0.09	1.28	T	0.21	8.52
1902	T	0.26	0.41	0.88	0.26	0.60	1.49	0.40	1.58	0.74	0.22	0.89	7.72
1903	0.11	0.36	1.09	0.73	1.63	1.00	1.31	0.88	2.37	0.54	0.30	0.07	10.37
1904	0.25	0.11	0.36	0.84	1.74	2.01	1.33	0.93	1.35	0.50	0.04	0.08	9.58
1905	0.39	0.42	0.64	1.21	1.79	0.36	1.79	0.83	1.62	0.46	0.22	0.03	9.76
1906	0.58	0.05	1.01	1.75	0.91	1.71	1.75	0.59	2.09	1.33	0.41	0.39	12.57
1907	0.29	0.15	0.28	0.78	1.09	0.90	3.68	1.28	0.62	0.16	T	0.23	9.46
1908	0.24	0.08	0.02	0.34	5.57	0.84	2.68	1.93	0.65	0.45	0.38	0.35	13.53
Sum	4.56	5.41	13.80	19.95	29.62	22.13	29.09	18.56	17.12	13.73	4.25	5.86	184.07
Means	0.25	0.30	0.76	1.10	1.64	1.23	1.61	1.03	0.95	0.76	0.24	0.33	10.22

WIND RECORD FROM JAN. 1, 1908 TO JAN. 1, 1909.

1908	North			N. East			East			S. East			South			S. West			West			N. West			Total
MONTHS	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles	Hours	Minutes	Miles
January	532	42	55	144	10	50	198	18	35	495	53	25	1024	123	15	5429	319	5	1032	57	30	1881	118	25	10735
February	1081	121	...	302	16	10	458	41	55	270	37	50	780	108	50	1433	90	25	2707	162	40	2286	117	10	9317
March	459	37	20	86	12	45	77	5	40	445	47	...	1043	105	35	6535	324	35	3250	121	25	1074	89	40	11969
April	357	43	15	362	25	10	152	20	15	1738	137	25	820	99	15	1149	102	55	1626	97	5	3718	184	40	10122
May	847	95	25	112	8	30	1026	68	50	2854	144	45	1159	94	10	1768	98	45	1774	111	35	1628	122	...	11168
June	476	43	50	233	14	45	670	43	45	2194	146	30	1148	132	...	3010	177	35	903	61	20	1372	100	15	10006
July	357	47	5	782	60	35	991	75	50	3388	269	5	690	93	10	423	41	25	263	28	10	1316	128	40	8210
August	391	54	20	416	34	55	767	59	35	2797	231	40	1127	145	20	1154	82	55	388	37	10	963	98	5	8003
September	432	47	...	92	13	55	280	48	20	1584	171	10	1097	148	20	1503	119	...	948	71	...	1359	101	15	7304
October	2106	153	5	458	33	55	500	26	45	1937	159	55	1883	168	55	1786	112	55	450	28	50	602	59	40	9722
November	1829	212	55	305	36	55	227	28	30	1846	167	10	2146	267	40	36	6	50	...	...	...	...	...	...	5889
December	968	112	20	406	33	5	53	6	10	757	101	20	6081	421	25	1100	44	45	40	5	20	355	10	35	9760
TOTAL	9635	1010	30	3698	301	30	5608	454	10	19805	1667	15	18998	1907	55	25326	1521	10	12891	762	5	16554	1139	25	112205

NOTE—Aveeage velocity for the year, 12.77 miles per hour.

WIND RECORD, 1908.

Direction	Percentage in miles	Percentage in time	Greatest Velocity Record: Month	Direction	Gt. Velocity	Date
North	8.77	11.51	January	N. W.	54	10
N. East	3.30	3.43	February	N. W.	44	19
East	5.00	5.17	March	S. W.	60	13
S. East	17.65	18.98	April	S. E.	60	23
South	16.93	21.72	May	S. E.	70	9
S. West	22.57	17.32	June	E.	68	1
West	11.03	8.90	July	N. E.	52	19
N. West	14.75	12.97	August	N. W.	42	31
	100.00	100.00	September	S. E.	48	14
			October	S. W.	43	15
			November	S.	30	17
				N.	30	25
			December	S. W.	44	29

SUMMARY BY MONTHS FOR 1908.

MONTHS	Temperature								Precipitation			Days									
	Maximum	Date	Minimum	Date	Means	Average Terrestrial Minimum	Mean Max.	Mean Min.	Total	Greatest in 24 hours	Date	Clear	Partly Cloudy	Cloudy	Average Dew Point	Average Relative Humidity	Average Vapor Pressure	Per Cent of Sunshine	Snowfall Inches	Average Solar Radiation	Barometer Average
January	45	8-18	—11	16	20	6.7	31.4	8.1	.24	0.10	15-30	14	14	3	10.3	66.0	.070	71.4	2.75	95.7	22.992
February	54	27	—22	1	25	8.4	39.3	9.6	.08	.04	4	13	14	2	12.0	67.0	.075	73.0	.85	91.4	22.934
March	64	17	—1	22	34	17.8	47.5	20.1	.22	.02	27	11	17	3	14.7	47.6	.085	70.0	.25	100.8	22.954
April	69	13	5	2	42	23.6	57.3	26.3	.34	.22	24	18	8	4	23.4	53.9	.129	70.7	. . .	120.9	22.995
May	74	19	17	5	45	29.5	57.5	31.7	5.57	2.18	24	11	13	7	32.6	63.6	.184	64.0	14.00	116.0	22.899
June	80	21	32	23	54	36.3	68.5	40.3	.84	.22	15-16	23	6	1	35.1	57.7	.168	79.0	. . .	122.4	23.042
July	84	25	33	2	61	44.5	75.4	49.9	2.68	.64	11	18	11	2	46.0	61.0	.325	73.4	. . .	122.0	23.224
August	86	9	28	31	60	43.6	73.6	47.0	1.93	.50	11	18	9	4	45.6	63.6	.314	73.7	. . .	118.0	23.23
September	84	7	14	27	55	34.9	71.6	38.3	.65	.40	14	20	6	4	33.7	49.6	.199	75.0	. . .	123.4	23.183
October	71	1	11	21	40	24.0	52.4	26.7	.45	.12	19	23	3	5	23.8	62.3	.129	73.4	2.45	88.7	23.118
November	62	4	—24	14	26	9.1	39.5	11.4	.38	.22	10	19	9	2	12.0	64.8	.078	72.3	4.05	81.7	23.096
December	44	3	—16	17	23	10.3	35.2	11.3	.35	.26	16	16	5	10	12.6	66.3	.070	60.4	3.90	81.7	23.038
Sum	817	. .	76	. .	485	288.7	649.2	320.7	13.53	. .	. .	204	115	47	301.8	723.4	1.835	865.3	28.25	1262.7	276.705
Average	68	. .	6.3	. .	40	24.06	54.1	26.7	1.13	. .	. .	. .	. .	. .	25.15	60.3	.153	72.1	. . .	105.2	23.059

THE UNIVERSITY OF WYOMING

AGRICULTURAL COLLEGE DEPARTMENT.

TWENTIETH ANNUAL REPORT

. . . OF THE . . .

U. S. Agricultural Experiment Station

. . . OF . . .

WYOMING

1909-1910

LARAMIE, WYOMING,
U. S. A.

Wyoming Agricultural Experiment Station

UNIVERSITY OF WYOMING
LARAMIE.

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F. E. HEPNER, M. S.............................Assistant Chemist
J. A. HILL, B. S...................................Wool Expert
O. L. PRIEN, M. D. V.................................Veterinarian
A. D. FAVILLE, B. S..........................Animal Husbandman
J. C. FITTERER, M. S., C. E.....................Irrigation Engineer
L. CHARLES RAIFORD, Ph. D....................Research Chemist
T. S. PARSONS, M. S...................................Agronomist
C. J. OVIATT, B. S...................Assistant Wool Investigations
G. R. HEBARD, A. M., Ph. D...........................Librarian
RHODA G. HOUTZ...Clerk
F. S. BURRAGE, B. A.....................................Secretary

Letter of Submittal

U. S. AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF WYOMING.

To the President of the University of Wyoming.

SIR:—In accordance with the act of Congress approved March 2, 1887, establishing and regulating agricultural experiment stations, and the act of Congress approved March 16, 1906, known as the Adams Act, I have the honor herewith to submit the Twentieth Annual Report of the U. S. Agricultural Experiment Station of Wyoming, for the fiscal year ending June 30, 1910.

J. D. TOWAR,
Director.

UNIVERSITY OF WYOMING, LARAMIE, WYO.,
June 30, 1910.

Letter of Transmittal

To the Honorable,
The Board of Trustees,
Of the University of Wyoming.

SIRS:—I have the honor to transmit herewith the Twentieth Annual Report of the Director of the University of Wyoming Agricultural Experiment Station, for the fiscal year ending June 30, 1910.

CHAS. O. MERICA,
President.

UNIVERSITY OF WYOMING, LARAMIE, WYO.,
June 30, 1910.

UNIVERSITY OF WYOMING,
OFFICE OF BOARD OF TRUSTEES,
LARAMIE, WYO., June 30, 1910.

To His Excellency, Governor Bryant B. Brooks.

SIR:—In accordonce with Chapter 51, Section 1, of the Session Laws of 1899, as President of the Board of Trustees of the University of Wyoming, I hereby submit to you that portion of the report of the Board of Trustees which refers to the Annual Report of the Director of the Agricultural Experiment Station and other members of the Station council, for the fiscal year ending June 30, 1910.

Respectfully submitted,
OTTO GRAMM,
President of Board of Trustees.

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Report of the Station Staff

Report of the Director

LARAMIE, WYO., June 10, 1910.

Charles Oliver Merica, President,
University of Wyoming,
Laramie, Wyo.

SIR:—Herewith I submit my annual report for the fiscal year ending June 30, 1910, together with the departmental reports of the Experiment Station for the same period. The year has been one of progress and accomplishment, yet none of the large lines of investigational work have reached the point of completion. Field experiments were carried on with more success and a greater degree of satisfaction than during either of the two preceding years, due to the more favorable weather conditions which prevailed throughout the summer.

The flocks and herds have been materially improved by purchase of imported stock and the natural increase through breeding and selection. The Station, with its flocks of pure breeds of sheep maintained for wool investigations and its animals used for breeding and feeding purposes, may reasonably claim to possess the best and most complete collection of sheep in the United States. The herd of polled cattle, through the breeding contract of J. M. Carey & Bro., has increased and developed so that at present the Station possesses 3 males and 8 females, all naturally polled and possessing the desirable qualities of purebred Herefords. The contract with J. M. Carey & Bro. terminated last autumn, and the bull "Mutation Second" was returned to the Experiment Station farm at Laramie. There still remains another year's

crop of calves to be divided and received from the Careyhurst herd. With these animals a splendid foundation herd is well established, and the important work of breeding and developing the Polled Hereford may be carried on with much interest and promise of success.

Owing to the lack of sufficient accommodations and a shortage of funds for the developing of the pig experiments, the Animal Husbandman has been compelled to limit his work with this kind of stock to the breeding and feeding of comparatively few animals. The field for breeding and investigational work with swine is, however, a broad and interesting one, and it is hoped that facilities will soon be provided for carrying on this work on a much larger scale. Nothing has yet been done with the developing of the poultry industry, and yet there is a splendid opportunity for branching out in this line as a future project.

The Irrigation Engineer has worked in co-operation with the Animal Husbandman to investigate certain practical problems relating to the duty of water. He has also interested himself in the cultivation problems connected with the dry farming project, which is recorded in the later pages of this report. His work in connection with the soil moisture investigations at Cheyenne terminated with the past season, and as soon as the Department of Agriculture provides him with the necessary data he will be able to prepare a suitable report on this work.

In the Department of Wool Investigations, carried on entirely as an Adams fund project, progress has of necessity been exceedingly slow, and thus far the results are decidedly inconclusive. Much careful and tedious work has been done in the testing of wool fibers, and the Wool Specialist, in the report he has prepared, has been able to mark progress only. The wool scouring plant, which is beginning its fourth year of operation, has about completed its function as a branch of the wool investigational work. The records that have already been secured will be ample for setting forth the facts

necessary to the present lines of investigation that have thus far been in progress. Unless some new phase of the wool investigation problem comes up or there is a decided further demand for wool scouring work, it is quite probable that the wool scouring may with propriety be discontinued after the present year.

The Chemical Department has been working away with laboratory study of forage plants and strictly scientific investigation of the chemical problems connected with the several projects to which this department is related.

There are many problems which could occupy the time of another department in which might be embraced that of botany, entomology and horticulture. While the University Botanist has acted in the capacity of consulting scientist in these various subjects, his manifold duties in the Agricultural College and University have prevented his undertaking any important project and devoting his time to it. With the growth of horticulture in the state, there will very soon be an imperative demand for a specialist along these lines. During the past year, however, the Botanist has worked merely as a consulting officer of the Station.

Weather Report.—The keeping of the weather records for the past year has been carried on under the direction of the Director of the Experiment Station. Unfortunately, the wind records for a portion of the year have not been kept, due to the fact of a defect in the instruments which could not be readily repaired. The taking of the weather records has been in the hands of Student John M. Jones, and his reports show care and promptness in the attention to his duties.

Range Sheep Breeding Experiment.—The range sheep breeding experiment, carried on through a co-operative agreement between the Experiment Station and the United States Department of Agriculture, has experienced no change in the general plan adopted at the inauguration of this work. The flocks have materially increased during the past year, and the

breeding stock and lambs are at present in most excellent condition. This experiment was planned to continue for a period of ten years at least, and while it is yet early to comment upon the results, it seems advisable that the original idea of developing a larger sheep with good fleece and better mutton form, should not be overlooked. Thus far the selection of breeding stock has included only animals of the fine wooled breeds, particularly the Rambouillet; and the introduction of specimens of the smaller type of sheep for sires, it seems, would not tend to produce the type of sheep it was originally planned to breed.

The Station Staff.—With the increasing necessity of more chemical work to carry on the various Adams fund projects, it was found necessary to add at least one chemist to the Station Staff. As the work of the Chemical Department naturally divided itself into two distinct lines, the Hatch fund projects which were already progressing were placed in the hands of Mr. Hepner, and for the strictly Adams fund investigations, Mr. L. Charles Raiford was appointed and began his duties early in the year. He has also had the assistance of Mr. H. H. Hill, a University student, who has contributed of his time as a laboratory assistant. To meet the demands for more work in the Department of Wool Investigations, Mr. Charles J. Oviatt was appointed as assistant, and took up his duties on the 1st of November. Early in the year Mr. L. B. McWethy, who for over two years had been the Agronomist, gave notice that he would retire on March 1st, and his position has been filled by the appointment of Mr. T. S. Parsons.

Under the present arrangement, many of the Experiment Station men are employed also by the University as teachers. This arrangement, necessitated in many cases by the shortage of funds, is by no means satisfactory, either to the Experiment Station or the University. It has been difficult indeed for these men to make a fair and impartial division of their time,

and as soon as the proper readjustment can be made, the Experiment Station and research men should be so appointed as to give their entire time to special lines of work.

Publications.—The Ranchman's Reminder.—The publication issued monthly by the Agricultural College, containing timely articles on various agricultural, live stock, and horticultural subjects contributed by members of the Station Staff, has continued throughout the year, this being the seventh year of its existence. This little magazine affords opportunity to place before the people many timely and imperative facts of importance which could not be readily issued in bulletin form. It takes the place of circulars and press notices which other stations are in the habit of publishing, and affords a very convenient means of keeping the work of the institution before the reading public of the state. The average issue is about 550, although occasionally special issues of a larger number are brought out. The editorship of this publication has been in the hands of the Director, although he has had liberal and valuable aid from other members of the Station Staff.

Early in the fiscal year, the annual report of 48 pages was issued. The Nineteenth Annual Report was formal in its character, containing but little in the nature of results or experimental work, this being reserved to publish in bulletin form.

Bulletins.—During the year three bulletins have been issued as follows: No. 83 by L. B. McWethy, on Barley; No. 84 by L. B. McWethy, on Field Peas; No. 85 by A. D. Faville, on Feeding Experiments 1909-10. The issue of these various bulletins numbers about 6,000.

Correspondence.—With the growing prominence of the Experiment Station, the public not only in our own state, but in other states, are rapidly recognizing the institution as a source of information, and no small amount of the work of the Director and various specialists consists in answering

letters of inquiry. While we are frequently able to meet these requests by mailing bulletins or numbers of the *Ranchman's Reminder,* there is a very large amount of work involved in replying to these letters. It seems a proper function, however, of the various members of the Experiment Station Staff to answer the many inquiries that come in this way. The work, however, deserves recognition, as it occupies much time and some work in looking up references. There is a line of inquiry, however, which could well be met if the Director's office was furnished with more printed documents relating to the character and resources of the various localities of the state. There is no particular office or board to whom many of these inquiries can be sent, but if each county in the state would provide the Director's office with circulars similar to those furnished by the Commercial Club of the city of Laramie, known as The Agricultural Resources of Albany County, and The Mining Resources of Albany County, embodying in these pamphlets the climatic conditions and everything that would interest a prospective investor or settler. much of the difficult work of answering these letters could be avoided and more complete and accurate reply to the letters made.

Acknowledgments.—The Experiment Station acknowledges with thanks the very large number of agricultural and other publications which are sent gratis or in exchange for the Experiment Station's bulletins and the *Ranchman's Reminder.* These publications are arranged in the Director's office, and are accessible to all students and members of the Station Staff.

Buildings.—The Experiment Station buildings on the Agronomy Farm are absolutely inadequate to meet the needs of that department. The completion of the barn for which the 1910 tax roll is to provide money, will very materially relieve that condition. The old Experiment Station barn.

which formerly occupied a place on the University campus, was torn down in the autumn of 1908 and re-erected on the Agronomy Farm, thereby furnishing a splendid granary and work room for the sorting and cleaning of grains. This building was erected over a basement cellar which is still left in the rough. An appropriation should be made to complete the basement of this building, in order that it may be used for the winter storage of potatoes and other roots. The buildings on this farm will be in fair condition and adequate for some time when the new barn is completed.

On the Stock Farm the arranging of the buildings will be a much more serious problem. The erection of a new horse barn and stock judging room has relieved one of the more serious conditions, but the old penitentiary building calls for a liberal appropriation to fit it up with suitable stalls for cattle. The Stock Farm is greatly in need of hog barns, and certain repairs are necessary on all the other buildings. When once these buildings are put in proper condition, by repair and remodeling, they will accommodate for some time all the live stock the institution will need for experimental purposes.

Projects.—Hatch Fund.—While not distinctly defined, the various departments working under the Hatch fund have planned and put into operation a series of experiments which should result in the discovery of some very interesting facts. The Agronomy Department is testing varieties of all kinds of farm crops, conducting cultivation and dry farming experiments, undertaking some plant breeding work by selection, working out plant adaptation, and in a small way carrying on some co-operative work. The co-operative work has consisted in the distribution of promising seeds in various parts of the state. No Adams fund projects are being conducted by the Agronomist.

The projects undertaken by the Animal Husbandman are enumerated in his report which follows, consisting principally

of feeding and breeding experiments with sheep. This officer has charge of the co-operative range sheep breeding experiment in connection with the Bureau of Animal Industry, and during the past year has devoted considerable time to the fitting and showing of sheep at the Alaska-Yukon, the International, and the National Wool Growers' expositions. In this department are also conducted the feeding and breeding experiments as Adams fund projects in co-operation with the Department of Wool Investigations.

In the report of the Wool Specialist, which follows, is given a summary of the work done by that department, all of which is carried on as an Adams fund project.

The only independent line of work the Chemical Department is conducting consists of forage plant investigations. This department, however, is doing some of the more important work with all of the Adams fund projects, and also some of the Hatch act work. In the report of the Chemists is outlined the various projects the Chemists are working on.

The Irrigation Engineer is carrying on field work in cooperation with the Agronomist, the principal project consisting in the study of the duty of water for various crops. This department has recently added two new projects which will be carried on as Adams fund projects, partly in co-operation with the Chemists.

Adams Fund.—In compliance with the regulations laid down by the Office of Experiment Stations, the Adams fund projects must be thoroughly outlined and the details mapped out in accordance with a prescribed plan. Below are given several Adams fund projects that have been accepted by the Office of Experiment Stations, the report of the Secretary, a somewhat detailed report of the work of the Agronomist and general reports of the heads of the various departments.

WYOMING EXPERIMENT STATION ADAMS FUND PROJECTS.

The investigations under the Adams fund planned for the present fiscal year, consist of four general subjects: 1. Wool Investigations; 2. Alkali Investigations; 3. Vegetable Poisons on the Range (confined to study of Woody Aster, *i. e. Xylorrhiza Parryi*); 4. Soil Moisture Investigations.

Wool Investigations.—The study of the various problems relating to wool has been going on for two years. The greater part of the work that has been done has consisted in a preliminary study as to methods. The study of wool fibers being a new field for scientific investigation, there was little at the beginning of these investigations to guide one as to the proper methods of studying co-efficients of variability, the breaking strain, elasticity, and other points regarding a scientific study of wool fiber. The discussion of the plans for wool investigation given herewith, puts forth the problem in a fairly clear light and pictures the enormity of the undertaking. The Wool Specialist has labored very faithfully, and done a great deal of work which thus far it has been impossible to lead to any definite conclusions. It looks as though it would take two or three years more before he could arrive at any results which will be of practical value. The equipment of the department consists in two fiber testing machines, and another will be added in a short time. There is also the wool scouring plant, which has served a fairly good purpose during the three years it has been in operation, and this feature of the work will probably not continue more than one year longer. The practical results obtained from that branch of the investigation are fairly well worked out. Under other funds, as a practical means of demonstrating something of value to the Wyoming wool growers, the wool scouring plant might be operated to considerable advantage. However, its usefulness in the study of wool under the projects herewith outlined, is nearly completed.

Quite an important branch of the wool investigation work will be carried on in the chemical laboratory as outlined by the Chemist. This work necessarily combines with the investigations carried on by the Wool Specialist, and in the final publication will form a part of the report. Some of the chemical work has also been done, and that is being continued strictly in the Adams fund laboratory. The study of environment on the character of wool has already started, a small flock of sheep being kept in Ohio, while a corresponding flock is being kept according to the outline of the project, in Wyoming. This feature of the experiment began the present season The feeding and breeding problem connected with the wool investigations has been going on at the Experiment Station since the first installment of the Adams fund was received A special feeding project is outlined herewith, which thoroughly explains itself. In this and the breeding experiments, the Animal Husbandman co-operates. The special branch of the work undertaken by the Director of the Experiment Station, for which a small allowance of salary is made, is the environment branch of the project. He will have complete charge of this work with the exception of the testing of fibers and the laboratory feature.

Alkali Investigations.—With the accompanying outline, little needs to be said in comment on the alkali investigation. On a portion of the University Farm there is a large area that up to 1908 had been receiving seepage water from the Pioneer Canal and irrigated land above. In the spring of 1908 a system of tile drains was installed in co-operation with the drainage investigations. A similar portion of the farm remains without tile drains, thus giving the Chemical Department an abundance of soil and all the conditions for studying alkali, both in the increasing and decreasing supply of alkali salts. The first object is the study of the movement of alkali salts in terms of ionic changes, and the other, a study of the effects of alkali upon seeds. These are both outlined

with a considerable degree of detail in the accompanying plans, and need no further comment here. The Irrigation Engineer contributes his time in the study of practical problems connected with this project, such as the application of water and the study of the rise and fall of the ground water and the runoff from the outlet of the drain.

Vegetable Poisons on the Range.—The necessity of this investigation was brought to our notice by reason of the numerous losses of sheep at certain seasons of the year, due apparently to some poisonous plant to which the sheep had access. The preliminary work of this project consisted in a study of the locations in the state where this plant is most common and in securing data from the sheepmen giving what information could be gleaned as to the nature and extent of the losses. This branch of the work is fairly well completed, and the field and laboratory work of the Veterinarian and the Chemists can be carried on the coming year with some hope of obtaining results. The field work for this project necessarily is confined to a short period in the early summer months. It is the plan that the Veterinarian and one or two assistants will go into the field at that time, and there collect materials and further data for the study of the poisons according to the outlines herewith submitted.

Soil Moisture Investigations.—Outlines to be submitted later. The old project, however, is being carried on, and the new one may continue in part at Cheyenne, but will gradually be transferred to Laramie.

DISBURSEMENTS OF THE FUNDS.

While the estimates of cost of carrying on the projects herewith submitted may not tally exactly with the funds provided for the current year, a more accurate arrangement for the disbursement of the Adams fund will be found in the following allotment passed upon by the Board of Trustees.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—Wool Investigations.

Project Number.—1.

Object of Experiment.—To determine the variability of wool fibers; to determine the causes of changes in the character of the wool fiber, and to determine the laws governing the hydroscopic water in wool with relation to the humidity of the atmosphere.

Location.—At Experiment Station, Laramie, except the environment determinations, a part of which are carried on in the state of Ohio.

Staff Personnel.—J. A. Hill and assistants, A. D. Faville. H. G. Knight and assistants, J. D. Towar.

Organization.—Wool fiber studies in wool laboratory: breeding and feeding at the University Experiment Station Stock Farm; chemical studies in chemical laboratory.

Division of Work.—Study of wool fiber in wool laboratory; chemical studies in the chemical laboroatory; feeding experiments in the Department of Animal Industry, and study of environment on Wyoming ranch and Ohio farms.

Method of Procedure.—See following pages; also development investigations.

Date Authorized.—July 1, 1908.

Date of Initiation of Experiment.—July 1, 1908.

Estimated Date of Completion.—Three to five years.

Estimated Cost.—$5,000 for the first year.

Sources of Maintenance.—Adams fund.

Publications Relative to the Experiment.—(a) Issued: Preliminary report in Eighteenth Annual Report of Station. (b) Projected or in preparation. Report of progress in bulletin form during the current year.

Results Other Than Publications.—None.

Suggestions as to Future Work.—Not yet prepared.

DISCUSSION OF THE PLANS FOR WOOL INVESTIGATIONS.

(Adams Fund.)

BY J. A. HILL.

A. PRELIMINARY WORK.

In the outline the preliminary work is divided into two main divisions, but, in fact, the entire work will consist of testing methods by means of the study of the variability of the wool fiber. This work is very important, because much of the regular investigation will be carried on by measuring the strength, elasticity, and diameters of the fibers of the various kinds of wool. It will therefore be necessary to know the number of fibers that will have to be tested in order to give a fair average for each sample.

The following is an outline of the method in which this work is being taken up:

Take twenty samples of wool of different grades, showing as wide a range of quality as possible.

Take 1,000 fibers at random from each sample and test them.

Test 10,000 fibers from each of two other samples, and compare the actual variation of the means of the separate thousands with the theoretical probable error.

Record the breaking strain and the elasticity, and, in at least five of the samples, measure the diameter of the fiber.

Calculate the means of the consecutive groups of tens and hundreds, and compare these with the mean of the entire thousand.

Calculate the standard deviation and the co-efficient of variability and probable error of the mean of the quantities named above, and also the relation which exists between the diameter of the fiber and its breaking strain.

B. REGULAR INVESTIGATION.

Study of the causes of the changes in the character of wool fiber from the normal.

Under this general head is grouped all the different lines of work which will be undertaken that bear on the great problem of why wool from the same grade of sheep is better in one locality than in another; why wool on the same grade of sheep differs from year to year in the same localities; and why there is so much difference in wool of the same breed of sheep grown under what appear to be the same conditions. The five ways in which this problem will be taken up follow:

Effect of Sheep Dips.—In this part of the work it is not only planned to study the effects of the different classes of dips, but also to determine, if possible, the ultimate physical, chemical, and physiological causes of these effects. The following is a general outline of the methods that will be followed:

(a) Test made on shorn wool.

1. Use dips of the four general classes: Lime and sulphur, tobacco, coal tar, and petroleum.
2. Use at least four different grades of wool.
3. Immerse five minutes in dip official strength.
   Immerse five minutes in dip 10 times official strength.
   Immerse 24 hours in dip official strength.
   Immerse 24 hours in dip 10 times official strength.
4. Divide dipped samples into three parts. One-third to be tested as soon as possible after dipping. One-third to be weathered for three months. One-third to be weathered for six months. Undipped samples will be used in each case as a check.
5. Dipped wools to be studied chemically and microscopically to determine the cause of

the ultimate chemical and physical changes, cause of difference in elasticity, strength and color of the wool which the experiiments show.

(b) Tests made by dipping sheep. The details of this part of the work will not be outlined until at least a part of the work outlined under (a) is finished.

HYDROSCOPIC WATER IN WOOL AND ITS RELATION TO STRENGTH AND ELASTICITY OF THE FIBER.

It is already known that wool with a high water content is stronger and more elastic than water-free wool; but there has never been any attempt to show any definite relation. It seems quite possible that this relation can be expressed as a mathematical formula. An attempt will be made to work out this formula, and also to discover any change which the water causes in the structure of the fiber which causes the change of properties.

Outline of methods:

(a) Take 10 samples of wool and divide each sample into five parts, containing 0, 2½, 5, 10, and 20% moisture, respectively.

(b) Determine the average breaking strain, elasticity, and diameter of each of these parts of samples.

(c) Make microphotographs in order to show any changes of structure that may be caused by the variation of the water content.

(d) Continue the work in this manner until enough wool has been tested to show some relation of moisture to strength of fiber and elasticity, which can be expressed by a formula, or until it is proved that no such relation exists.

EFFECT OF THE ENVIRONMENT OF THE ANIMAL.

This will be studied from the standpoint of the difference between wool from sheep grown in Ohio and wool from the same class of sheep grown on the Wyoming range.

Outline of methods:

(a) Select ten range sheep from five different breeds. Shear for two years, saving the wool. Ship the sheep to Ohio and keep under ordinary conditions. Shear for two years, saving the wool.

(b) Select ten Ohio sheep from five different breeds and shear two years there; then ship them to Wyoming and run on the range. Shear two years and save the wool.

(c) Shear five range sheep of different breeds, saving the wool. As soon as they are shorn cover the sheep as completely as possible with canvas for a year, and shear again, saving the wool.

(d) The wool secured from the last three experiments should be studied as follows.

1. Test shrinkage;
2. Test strength of fiber;
3. Test elasticity;
4. Determine variability of the fibers;
5. Measure diameter;
6. Photograph the fibers to show any structural differences;
7. Compare the different samples as to color;
8. Determine if possible any differences that there may be in the physical structure of the fiber;
9. Have the chemist determine the difference in chemical composition of the dirt found in the fleeces and also of the pure wool.

(e) Further experiments made by varying the food and water given to Wyoming sheep may be required to complete this study, but they will not be undertaken until the work outlined has been finished, or nearly so.

SHRINKAGE OF WOOL WITH RELATION TO THE GENERAL CHARACTER OF THE WOOL FIBER.

First an attempt will be made to work out for given localities the relation of shrinkage to length and diameter of fiber. An attempt will also be made to determine the cause of the relative weakness of fiber in heavy shrinkage wools. In other words, to show the manner in which an excess of dirt and sand affects wool to bring about a weakening of the fiber.

Outline of methods:

(a) Scour samples of wool from all the different counties of Wyoming four consecutive years, on a commercial basis. The wool can be obtained without cost to the Experiment Station by giving the owners of the wool a report on the shrinkage.

(b) Take samples from at least four parts of each fleece scoured: Shoulder, back, thigh, belly.

(c) Determine the shrinkage of these small samples and compare it with the general average of the large samples.

(d) Determine the amount of grease, soluble salts, and insoluble dirt in each of the small samples.

(e) Measure length, diameter, and strength of fiber in each small sample.

(f) Study the dirtiest samples with the microscope to discover any effect that the grinding of the sand may have upon the structure of the fiber.

BREEDS AND THE EFFECTS OF CROSS BREEDING.

The object of this part of the work is to determine the degree of variation of wool fiber caused by the crossing of breeds, and to work out the laws governing this variation.

The following is a partial outline of the manner in which this question will be taken up:

(a) Have four ewes of each of the following breeds:
Fine Wool—Delaine, Rambouillet.
Medium Wool—Oxford, Hampshire, Tunis, Horned Dorset.
Long Wool—Lincoln, Cotswold.

(b) First year breed half to a Rambouillet ram and half to a Cotswold ram. Second year breed half to a Delaine ram and half to a Lincoln ram. Third year half to a Tunis and half to a Hampshire ram. Fourth year half to an Oxford and half to a Horned Dorset. Cross the offspring so as to produce quarter blood of the male parent, also of the female parent.

It is impossible at present to outline the crossing any more in detail.

(c) Wool from all the sheep in this experiment will be:
1. Weighed;
2. Scoured;
3. Moisture content determined;
4. Breaking strain determined;
5. Elasticity determined;
6. Diameter of fiber measured;
7. Variability of the avobe qualities determined.

HYDROSCOPIC WATER IN WOOL IN RELATION TO THE HUMIDITY OF THE ATMOSPHERE.

The object of this study is to formulate the laws which govern the water content of air-dry wool, and the manner in which the change in water content follows the changes in the humidity of the atmosphere.

Outline of methods:

(a) Find the average water content of Wyoming wool.

(b) Find the average water content of Eastern wool.

(c) Find the average water content of Wyoming wool after it has been stored at sea level for different periods ranging from two weeks to six months.

(d) Test the water content under varying conditions of humidity that are controlled by artificial means.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—Wool Investigations.

Project Number.—1

Object of Experiment.—To determine the causes of changes in strength of wool fiber from the normal.

Location.—Wyoming Experiment Station, Laramie, Wyo.

Staff Personnel.—Henry G. Knight, L. Chas. Raiford, John A. Hill.

Organization.—Chemists in co-operation with Wool Expert.

Division of Work.—Wool Expert to make physical tests; Chemists, chemical work.

Method of Procedure.—

(a) Effects of various reagents upon strength of wool fiber.

(b) Per cent. of wool fat and its relation to strength of fiber.

(c) Per cent. of salts and soaps in wool and its relation to strength of fiber.

(d) Composition of wool fiber and its relation to strength.

(e) Co-operation with wool work outlined by Mr. J. A. Hill.

Date of Initiation of Experiment.—Spring, 1908

Estimated Date of Completion.—Three years from date.

Estimated Cost.—Not over $300 per year.

Publications Relative to the Experiment.—

(a) Issued, none.

(b) Projected or in preparation, none.

Results Other Than Publications.—It has been found that certain salts found upon the plains apparently weaken the fiber.

This project sheet submitted by Henry G. Knight and L. Chas. Raiford Sept. 18, 1909.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—Wool Investigations; Development Project; The Effect of Feed on the Total Wool Product.

Project Number.—1.

Object of Experiment.—To determine the influence of wide and narrow rations on the amount, quality, and composition of raw and washed wools.

Location.—Wyoming Experiment Station Stock Farm, situated near the city of Laramie.

Staff Personnel.—H. G. Knight, Station Chemist; J. A. Hill, Wool Specialist; A. D. Faville, Animal Husbandman; James McLay, Foreman of Stock Farm.

Organization.—Department of Animal Husbandry to have charge of the feeding and care of the animals and all records connected therewith. The Departments of Wool Investigations and Chemistry to make all physical and chemical tests necessary in the working out of the problem.

Method of Procedure.—Thirty lambs to be taken at weaning time in the fall and put on the same feed until February or March. Shear at this time and divide into three lots as evenly as possible. Carefully study all wool at this time. Put sheep on feed with rations approximating 1:4, 1:8, and 1:12, and keep under known conditions continually. At the end of a year shear and compare lots of wool with one another and with previous clip. After this clipping, reverse the lots and continue the experiment another year. Reverse

again when each lot will have been under all conditions. A normal check lot may be run through the entire period.

Date of Initiation of Experiment.—Fall of 1909.

Estimated Date of Completion.—Spring of 1912.

Estimated Cost.—$500 per year for feed.

Publications Relative to the Experiment.—

(a) Issued, none.

(b) Projected or in preparation, none.

Suggestions as to Future Work.—It would probably lead up to a more detailed study of the variations in wool composition as influenced by feed.

This project sheet submitted by A. D. Faville.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—Alkali Investigations.

Project Number.—2.

Object of Experiment.—Study of vertical movement of alkali salts in terms of ionic changes. (Laws which govern.)

Location.—Experiment Station, Laramie, Wyo.

Staff Personnel.—Henry G. Knight, L. Chas. Raiford, Chemists.

Organization.—Chemists independently.

Method of Procedure.—Study of the vertical movement of alkali in terms of ionic changes. To study the ionic variations in an alkali spot at various depths:

1. Under conditions when there is an excess of evaporation over rainfall.
2. Under conditions where rainfall exceeds evaporation.
3. Solutions are concentrated.
4. Solutions are dilute.

Date of Initiation of Experiment.—Fall of 1909.

Estimated Date of Completion.—Five years from date.

Estimated Cost.—For year 1909-10 probably not more than $400.

Publications Relative to the Experiment.—

(a) Issued, none.

(b) Projected or in preparation, none.

This project sheet submitted by Henry G. Knight and L. Chas. Raiford Sept. 18, 1909.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—The Effect of Alkali Upon Seeds.

Project Number.—2.

Object of Experiment.—Formulation of the laws of alkali absorption by seeds.

Location.—Chemical laboratory, Wyoming Agricultural Experiment Station.

Staff Personnel.—Henry G Knight, L. Charles Raiford.

Organization.—Experiment to be taken up independently by the chemists, but has a bearing upon all the alkali work done or in progress at the Wyoming Experiment Station.

Division of Work.—

A. Ionic considerations:

- a. Effect of ions of high velocity on those of relatively low velocity.
- b. Effect of ions of low velocity on those of relatively high velocity.
- c. The effect of mixed salts.

B. Toxic effects.

- a. Study of the action of soil extracts of different concentrations.
- b. Study of aqueous solutions containing the same alkali salts, in corresponding concentrations made from pure chemicals.

Estimated Date of Completion.—Three years from date.

Estimated Cost.—Not over $300 per year.

Publications Relative to the Experiment.—

(a) Issued: Alkali VI., 16th Annual Report of this Station.

Results Other Than Publications.—None.

Suggestions as to Future Work.—Impossible to determine what might be the outgrowth of this investigation.

This project sheet submitted by Henry G. Knight and L. Charles Raiford.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—Woody Aster.

Project Number.—3.

Object of Experiment.—Study of Toxic Principle.

Location.—Wyoming Experiment Station.

Staff Personnel.—Henry G. Knight, L. Charles Raiford, Chemists; Dr. O. L. Prien, Veterinarian.

Organization.—Chemist in co-operation with the Veterinarian.

Division of Work.—Chemists to take up purely chemical work upon the active principle. (See O. L. Prien's project for this portion of the work.)

Method of Procedure.—

1. Separation and classification of toxic principle.
2. Conditions favoring increase.
3. Antidotes.
4. Effects according to method of administration. (Collaboration with Veterinarian.)
5. Effects according to preparation. (Collaboration with Veterinarian.)
6. Tests with various reagents to determine characteristic reactions.

Estimated Date of Completion.—See O. L. Prien's project.

Publications Relative to the Experiment.—

(a) Issued, none.

(b) Projected or in preparation, none.

Suggestions as to Future Work.—Work similar should be carried on with other poisonous plants.

This project sheet submitted by Henry G. Knight and L. Charles Raiford Sept. 18, 1909.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—Vegetable Poisons of the Range. (Woody Aster, *i. e. Xylorrhiza Parryi.*

Project Number.—3.

Object of Experiment.—Determination of the toxic principle of the symptoms and pathological changes occasioned, per cent of deaths; toxic doses and antidotes.

Location.—Experiment Station, Laramie, Wyo., and fields where losses are occurring.

Staff Personnel.—O. L. Prien, Veterinarian; H. G. Knight and L. C. Raiford, Chemists.

Organization.—Co-operation with Chemist in the study of toxic principle. (See (g) of Part II.)

Division of Work.—Field work and laboratory work by the Veterinarian. Laboratory work on toxic principle and antidote in collaboration with Chemist.

Method of Procedure.—

I. Field observations.

(a) Occurrence.

(b) Losses.

1. Time of year losses are greatest.
2. Factors apparently favoring losses.
3. Factors apparently favoring recovery.
4. Per cent. of deaths among affected.

(c) Symptomology.

(d) Duration of illness.

(e) Pathological lesions.

(f) Conditions favoring increase of toxic principle.

NOTE.—Dependent on toxic principle being an inorganic compound.

II. Laboratory Experiments.

(a) Physiological action.

(b) Duration of illness.

(c) Rapidity of elimination.

(d) Rapidity of recovery.

(e) Toxic doses.

(f) Pathological lesions. Causes of death.

(g) Study of toxic principle. (See outline by Chemists.)

Date of Initiation of Experiment.—April, 1909.

Estimated Datct of Completion.—Three or four years from date.

Estimated Cost.—$800 to $1,000 each year.

Sources of Maintenance—Adams fund.

Publications Relative to the Experiment.—

(a) Issued, none.

(b) Projected or in preparation, none.

Results Other than Publications.—None.

Suggestions as to Future Work.—None as yet.

ADAMS FUND SALARIES AND CONTINGENT.

Director	$ 400	Wool Investigations
Wool Specialist	1,500	Wool Investigations
Animal Husbandman	300	Wool Investigations
Chemist	300	Co-operating in all four projects
Assistant Chemist	400	Co-operating in all four projects
Assistant Chemist (Research)	1,400	Co-operating in all four projects
Student Chemist	350	Co-operating in all four projects
Veterinarian	800	Poisonous Plants
Irrigation Engineer	450	Soil Moisture Investigations
Farm Foreman	150	Soil Moisture Investigations

Herdsman	780	Wool Investigations
Stenographer	350	Wool, Poisonous Plants, and Soil Moisture Investigations
Assistant in Wool	800	Wool Investigations
Animal Husbandry	1,860	Wool Investigations
Sheep and Wool Investigations	600	Wool Investigations
Chemistry	1,000	All four projects
Soil Moisture Investigations	225	Soil Moisture Investigations
Traveling, Permanent Improvements, Library, Freight and Express	935	Distributed throughout the four projects
Alkali Investigations	200	Alkali Investigations
Veterinary	200	Poisonous Plants
	$13,000	

Project No. 4 never definitely outlined. Carried on in co-operation with Office of Experiment Stations. Completed at the end of season of 1909.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—The Percolation of Water Through Soils.

Project Number.—5.

Object of Experiment.—To determine the rate of percolation of irrigation waters through adjacent lands at lower levels.

Location.—University farms, Laramie, Wyo.

Staff Personnel.—Prof. J. C. Fitterer, Irrigation Engineer.

Organization.—To be carried on entirely by the Irrigation Department of the Experiment Station.

Method of Procedure.—

A. Field Experiments.—To dig tile-lined wells in the center of each acre plot on the Agronomy Farm, and (a) thereafter to take measurements of the water table in these wells, both during the irrigating season and during the balance of the year. (b) To run levels over these wells and to plot

profiles thereof, which, together with the topographic map of this farm already made, will completely summarize the relief features. (c) To keep a record of the times and amounts of all the irrigation water turned onto these plats, as well as its first appearance and subsequent fluctuation in the Pioneer Canal flowing just above the tract in consideration. (d) To keep a record of the precipitation. (e) To examine and record the physical soil structure to the depth of the bottom of the tile wells. (f) To place some soluble pigment in the line of wells nearest the Pioneer Canal, and note the time of its subsequent appearance in the lower ones. (g) To note any additional conditions and events which might have a bearing upon the proposed problem.

B. Laboratory Experiments.

a. Vertical Percolation: To determine the rate of percolation through soil of

(1) Uniformly-sized particles and under constant heads of water.

(2) Uniformly-sized particles and under fluctuating heads.

(3) Mixed particles and under constant heads.

(4) Mixed particles and under fluctuating heads.

b. Horizontal Percolation, treated in a manner similar to (a).

Date Authorized.—May 1, 1910.
Date of Initiation of Experiment.—May 1, 1910.
Estimated Date of Completion.—2 or 3 years.
Estimated Cost.—$400 first year.
Sources of Maintenance.—Adams fund.

Publications Relative to the Experiment.—

(a) Issued, none.

Results Other than Publications.—None.

Suggestions as to Future Work.—Seepage investigations, alkali deposits, and causes of water-logging of lands. Study of plants premonitory of alkali formation.

This project sheet submitted by J. C. Fitterer April 20, 1910.

THE UNIVERSITY OF WYOMING.

EXPERIMENT STATION PROJECTS.

Subject of Experiment.—The Effect of Alkali upon Structural Materials.

Project Number.—6.

Object of Experiment.—To determine the deteriorative effects and related causes of alkali in aqueous solution upon the various materials used about the farm.

Location.—Agronomy Farm, Laramie, Wyoming.

Staff Personnel.—Prof. J. C. Fitterer, Irrigation Engineer, assisted by Research Chemist of the Chemical Department.

Organization.—To be carried on conjointly between the Irrigation and Chemical Departments.

Division of Work.—All work except the chemical analyses to be carried on by the Irrigation Engineer.

Method of Procedure.—

A. Cement and Cement Mortar.—

(a) To make numerous dupilcate sets each of cubes and briquettes composed (1) of neat cement, (2) of 1 to 1, (3) 1 to 2, (4) 1 to 3 mortar. The cement to be subjected to physical laboratory analysis in connection with this work. (b) One series of duplicates to be immersed in alkali impregnated water, say in the alkali pool on the Agronomy Farm, and the same to be removed and tested at

the expiration of 1 week, 4 months, 3 months, 6 months, and longer, if found necessary. (c) The remaining series of duplicates to be left in the laboratory and kept immersed in water free from alkali and tested simultaneously with those under (b).

B. To treat in a similar manner (in pure and alkali water) the following substances under the various forms specified

1. Wood (test pieces fence posts) various woods.
2. Steel.
3. Iron.
4. Concrete (cement, sand, broken stone or gravel, fence posts, tile, etc.).
5. Clay tile—glazed and unglazed.
6. Brick—various kinds and hardness of burning.

The treated and untreated specimens to be subsequently examined and tested.

C. To make chemical analyses of the materials and immersion fluids, as found necessary.

D. To subject all of the above materials to various saline solutions of definite composition.

E. To subject the same to alternate immersion and evaporation in air.

Date Authorized.—May 1, 1910.

Date of Initiation of Experiment.—May 1, 1910.

Estimated Date of Completion.—2 or 3 years.

Estimated Cost.—$300 first year.

Sources of Maintenance.—Adams fund.

Publications Relative to the Experiment.—

(a) Issued, none known.

(b) Projected or in preparation, none known.

Suggestions as to Future Work.—Depends largely upon results.

This project sheet submitted by J. C. Fitterer, April 20, 1910.

Financial Statement of the Treasurer

UNIVERSITY OF WYOMING.

AGRICULTURAL EXPERIMENT STATION

IN ACCOUNT WITH

THE UNITED STATES APPROPRIATION, 1909-1910

DR.

To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ending June 30, 1910, under Acts of Congress approved March 2, 1887, and March 16, 1906—

Hatch Fund	$15,000.00
Adams Fund	13,000.00

CR.

		Hatch	Adams	
By	Salaries	$8,070.00	$ 7,489.16	
	Labor	1,672.54	268.76	
	Publications	376.52	....	
	Postage and stationery	268.21	63.55	
	Freight and express	316.74	324.02	
	Heat, light, water and power	592.52	152.56	
	Chemical supplies	285.36	887.35	
	Seeds, plants and sundry supplies	421.96	248.38	
	Feeding stuffs	1,499.11	2,024.71	
	Library	10.00	4.48	
	Tools, implements and machinery	313.81	29.38	
	Furniture and fixtures	23.50	103.94	
	Scientific apparatus	94.65	1,034.01	
	Live stock	384.90	296.00	
	Traveling expenses	303.33	61.95	
	Contingent expenses	15.00	....	
	Buildings and land	351.85	11.75	
	Total	$15,000.00	$13,000.00	$28,000.00

We, the undersigned, do hereby certify that we have examined the books and accounts of the University of Wyoming Agricultural Experiment Station for the fiscal year ending June 30, 1910; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have

been $28,000.00 and the corresponding disbursements $28,000.00, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887, and the act of Congress approved March 16, 1906.

(Signed)

OTTO GRAMM,
V. J. TIDBALL,
A. C. JONES.

Attest:

FRANK SUMNER BURRAGE,
(Seal) *Custodian of Seal.*

SUPPLEMENTARY STATEMENT.

DR.

	Farm Products	*Total*
To balance on hand	$1,077.46	
Receipts from other sources than the United States for the year ended June 30, 1910	5,541.79	$6,619.25

CR.

By Salaries	$ 50.00	
Labor	446.35	
Publications	19.59	
Postage and stationery	12.70	
Freight and express	359.77	
Heat, light and water	14.00	
Seeds, plants and sundry supplies	249.12	
Fertilizers	8.15	
Feeding stuffs	2,184.24	
Tools, implements and machinery	31.45	
Furniture and fixtures	18.98	
Live stock	424.82	
Traveling expenses	888.05	
Contingent expenses	1,419.58	
Building and repairs	156.34	
Balance	336.11	
	$6,619.25	$6,619.25

Agronomy

L. B. M'WETHY, J. D. TOWAR.

The agricultural experiments for the year 1909 gave the most satisfactory results obtained during the past three years. An early spring was followed by a warm, growing summer, and the autumn was especially favorable for harvesting, threshing and caring for the season's crops. Owing to the serious weather conditions of 1908 we were able to mature seeds of but few crops. So completely did the early frost of that year destroy the germinating power of the cereal grains that all beginnings in plant breeding were completely destroyed, and this work had to be started anew in 1909. The previous experiments had developed a few interesting varieties which might have served a useful purpose in carrying on this work, but it was impossible to germinate seeds from the 1908 crop, so that all the past work in this line was completely destroyed and a new start made in 1909.

Plant Breeding.—To start in with the developing of plants adapted to the high altitude conditions of the Laramie valley, we were guided somewhat by the experience of former years in the selecting of varieties for beginning this work. In addition, however, to the selecting of a few known varieties, a large number of new sorts were introduced, and the plant breeding work practically started out afresh with most of the seeds untried and partially unknown as to their adaptability to local conditions. With this condition, the principal work undertaken during the year consisted in making improvements through selection only. In the absence of the necessary knowlegde of characteristics and adaptability of varieties, no attempts at crossbreeding or hybridizing were undertaken. The field notes, however, were carefully recorded and the final results will serve as a guide for future work in plant breeding with these new plants.

Alfalfa.—Seeds from various parts of the world, secured largely through the Bureau of Plant Industry, were planted

in hills and rows to give each plant liberal space in which to grow and develop seeds. Many of these imported seeds have failed entirely either to germinate or to withstand the winter, while in these breeding plots are many stronger plants giving promise of success and decided improvement on our common alfalfas. The plants that have wintered successfully will be carefully watched the coming season, and their seeds selected for future planting. It is yet too early to offer even a suggestion as to which of these alfalfas is even the most promising, although it is hoped that in the large list of varieties some improved individual plants will be found which may be especially adapted to local conditions.

Cereals.—Barley, oats, and wheat were grown from new and imported seeds, selections in some cases being made from individual plants. The quantity of seed in many of the varieties was so small that the first season's crop was all saved with the view of securing more plants from which to make in the future the systematic selections. The test took on more the form of a variety test than a plant breeding project. Several of the imported varieties of barley looked very promising, and two or three varieties of wheat from Australia seemed to fit closely the conditions prevailing in the Laramie valley. While the experiment was largely a variety test, the area devoted to these several varieties was so small that a calculation of acre averages would be extremely misleading. However, the growth of many of these crops planted in small rows was so far ahead of the more common varieties that the prospects are most encouraging. Further comment is made upon these cereals a little further along in this report.

Oats.—Oats are destined to be one of the main crops as a source of grain for Wyoming. The severe weather conditions of 1908 made it impossible to mature any seed on the Station Farm. Hence, in the study of this crop it was necessary in the spring of 1909 to secure new seed from out-

side sources. Varieties of oats were bought from Barteldes Seed Co., Denver; Northrup, King & Co., Minneapolis, Minn.; and one or two varieties from Canada, and one or two sorts that were of local origin. Such a diversified source of seed made any comparative test impractical during the first season.

The varieties of oats were sown on plot 28, which had been devoted to potatoes the previous year, and was only thoroughly harrowed in preparation for the oats. The experience of the season suggests a few items that may be of interest. The use of black oats did not seem feasible, because of their somewhat late maturing nature. Furthermore, they are not popular from a market standpoint. It is the plan to discard all oats of this type. Some of the heavier yielding sorts are of the open panicled and white grain type—Swedish Select, Lincoln, American Banner, and others. Varieties of this class gave the best yields during the past season. However, the high altitude conditions demand an early maturing sort. The Kherson and 60-Day oats are especially suited to meet this need, and it is our conviction that the attention should be more largely given to these early maturing sorts. as far as high altitude conditions are concerned. The Kherson variety has exhibited a little preference in yielding power as compared with the 60-Day variety. It is again very difficult to develop under high altitude conditions a type of oats suitable to regions with longer seasons of growth.

VARIETY TEST OF OATS. 1909.

NAME	Area in sq. ft.	Yield in lbs.	Yield in lbs. per acre	Yield in bu. per acre	Time of maturity
Black Beauty	3300	130	1716	53.6	Sept. 18
Regenerated Swedish Select	4387	226	2244	70.1	Sept. 8
Black Oats	2200	98	1940	60.6	Sept. 20
Sixty-Day	2200	108	2138	66.8	Aug. 29
Danish Island	2200	128	2534	79.2	Sept. 12
Colorado No. 37	2170	117	2348	73.4	Sept. 10
Lincoln	2185	125	2492	77.9	Sept. 11
American Banner	2200	129	2554	79.8	Sept. 11
Delmaine	3300	195	2574	80.4	Sept. 10
Lincoln	2200	143	2831	88.5	Sept. 11
Sixty-Day	2200	113	2237	69.9	Aug. 29
New Market	2200	133	2633	82.3	Sept. 9
Kherson	2200	118	2336	73.	Sept. 30
Black Oats	2200	101	2000	62.5	Sept. 30

Barley.—Reports of this crop are given fully in Bulletin 83, February, 1910.

Wheat.—Trials of winter wheat were made from the 1908 seedings. From the result of the year's experiment with winter wheats it was found that splendid yields were secured this season. These results, however, seem to be rather better than the average of past years, and therefore no definite conclusions can be arrived at from this experiment, although judging from the year's results, there is some considerable prospect of the successful and profitable growing of winter varieties. The four varieties tested were the Kharkov, Turkey Red, Defiance, and

Spring Wheats.—The great difficulty with growing the common varieties of spring wheat is apparently due to our short seasons. During neither the season of 1907 nor 1908 were we able to mature any of the popular varieties of spring wheat in this locality. An importation of a large number of varieties of Australian wheats was made in the winter of 1909, and these varieties were tested in a small way. A number of the varieties proved to be either too tender for this cold climate or required too long a season. The Australian varieties of wheat have been developed into early and late sorts to a greater extent than in this country. It was found

that only the earlier varieties would mature, and two or three of these gave much promise, particularly a variety known as the John Brown. In the test where only a small quantity of seed was used, computing of the yield was unfair and misleading. However, in comparison with other varieties, the John Brown gave promise of yielding over 40 bushels to the acre. Tests of the John Brown, Medeale, and the Turkey Red (a winter wheat), were made at the Omaha Corn Exposition, and the results are herewith appended.

SAMPLE NO. 19, MEDEALE (SPRING WHEAT).

Weight per bushel, 57 lbs.
Weight of sample, 4 lbs. 0 oz.
Weight of flour, 2 lbs. 10 oz. 65.6%
Weight of bran, 8½ oz. 8.5%
Weight of shorts, 14¾ oz. 23.1%
Total weight, 3 lbs. 14¼ oz.
Loss in milling, 1¾ oz. 2.8%
Yield per barrel, 4 bu. 58 lbs.
Amount of flour used, 340 gr., or 12 oz.
Amount of water user, 5.56 fl. oz.
Volume of loaf, 98 cu. in.
Amount of wet gluten, 21.6%, very poor.

SAMPLE NO. 20, JOHN BROWN (SPRING WHEAT).

Weight of sample, 4 lbs.
Weight per bushel, 61 lbs.
Weight of flour, 2 lbs. 9 oz. .... 64 %
Weight of bran, 0 lb. 9½ oz. 14.8%
Weight of shorts, 0 lb. 9 oz. 14.1%
Total weight, 3 lbs. 11½ oz. 92.9%
Loss in milling, 4½ oz. 7.1%
Yield per barrel, 5 bu. 6 lbs.
Amount of flour used, 340 gr., 12 oz.
Amount of water used, 6.25 fl. oz.
Volume of loaf, 158 cu. in.
Amount of wet gluten 44.4%

SAMPLE NO. 21, TURKEY RED (WINTER WHEAT).

Weight of sample, 4 lbs.
Weight per bushel, 61.5 lbs.
Weight of flour, 2 lbs. 12 oz. 68.8%
Weight of bran, 0 lb. 15 oz. 23.4%
Weight of shorts, 0 lb. 4 oz. 6.2%
Total weight, 3 lbs. 15 oz. 98.4%
Loss in milling, 0 lb. 1 oz. 1.6%
Yield per barrel, 4 bu. 45 lbs.
Amount of flour used, 340 gr., 12 oz.
Amount of water used, 6.66 fl. oz.
Volume of loaf, 115 cu. in.
Amount of wet gluten 34.8%

It will be noted that the John Brown showed a much higher per cent. of gluten and gave a very much larger volume of loaf than the Turkey Red, a very popular milling variety. The only place where it fell short of the other varieties was in the high loss in milling. It must be remembered that very small samples were used in this test, which will readily explain where an extraordinary loss might appear in one variety and not show up so marked in another. There is no particular reason why one variety should not mill out within one or two per cent. of its original amount.

Immediately upon discovering the remarkable performance of this variety another importation was ordered. This, however, has arrived too late for sowing this year, and the test the present season will be limited to the small quantity of this sample which was saved from last year's sowing. Unfortunately four pounds of the first year's crop had to be used for the milling test. There is very much promise for the John Brown wheat in this locality, and when it can be more extensively propagated, it is hoped that it may find a place on the farms of the state.

Field Peas.—That all leguminous crops are of great importance to the farmer is a conclusion long since arrived at, and generally well understood by both planters and feeders. While alfalfa has proven itself the best forage plant for the inter-mountain conditions as a concentrate feed, the field pea is rapidly coming into prominence. This, too, is a legume and the feeding qualities of the seeds are of especial importance in the feeding and fattening of lambs and hogs. The increasing importance of this crop, then, is a vote for extensive experimentation. In the high altitude of the Laramie valley the short season forbids the growing of Indian corn, milo maize, and other of the more tender agricultural plants, but the field pea seems to be able to withstand the low night temperatures which prevail in this altitude and make even more growth than they do in the more humid and warm climates.

The plant is also practically free from the usual fungous and bacterial diseases that attack the plant where more warmth and moisture prevail. The maximum crops are obtained with a less amount of seed than it is necessary to use in other localities. Furthermore, as a feed not only the seeds of the peas are particularly valuable and nourishing, but all kinds of live stock seem to relish and thrive on the vines and pods, even when left to mature and dry in the fields. The usual method of feeding out this crop is to turn in sheep or lambs and allow them to graze in the field in the autumn until they can no longer secure enough feed to keep them in good growing condition. Hogs are then turned in and the work of harvesting the crop is soon completed. The yields of peas in localities where this method is practiced are usually computed in pounds of mutton or pork or in the number of lambs and hogs that can be fattened on an acre. This varies from 5 to 12 lambs and 1 to 2 hogs. The results of the year's work with field peas on the Agronomy Farm are recorded in Bulletin No. 84, which has already been mailed.

In recounting the merits of this interesting crop, its value as a soil renovator should not be overlooked. The field pea, through the action of soil bacteria, is capable of assimilating large quantities of atmospheric nitrogen, and, judging from the abundant growth of the nitrogen nodules on the roots of some of the pea plants, it is a safe wager that a crop of field peas will leave more nitrogen in the soil than it removes.

The Garden Pea Industry.—While peas are sometimes classified as field and garden sorts, there is absolutely no difference in their method of growth, their natural characteristics, and the effect that their growth has upon the soil. The growers of garden peas find market for the green peas in the pod, for green peas sent to the canning factory, and for the ripe peas to be used for seeds. The soil in the Laramie valley has proven itself particularly well adapted to the producing of an excellent quality of green peas for table

use. An interesting characteristic of the plant in this locality is the fact that the peas remain green on the vines for a very long time. This quality, noticeable here, has its advantages in providing a longer season of harvest, thus avoiding the necessity of frequent plantings to keep up the family supply. This character should argue for the establishing of a pea canning factory in this locality.

One of the serious difficulties in producing garden pea seeds is the pea weevil, as well as diseases that attack the vines. The growers of garden pea seeds find it necessary to select areas in the colder northern states for the growing of their annual supply. Recently one of the large seed growers has been attracted to this locality, and a contract for a large acreage has been already let. Both field and garden peas grown in the Laramie valley are absolutely free from the pea weevil, and there is every reason to hope that this industry may thrive and pea seeds become an important agricultural product.

From the variety test of field peas, results of which are recorded in Bulletin No. 84, it was found that the French June and the Prussian Blue, two comparatively new varieties, gave the best results in the yield of ripe peas. These figures may not serve as a guide in determining which is the best variety to grow in this locality, from the fact that other varieties, like the Marrowfats, produce an abundant growth of vines, and the feeding value of pea vines is a feature not to be overlooked in the growing of this important crop. The table of the variety test is herewith given:

VARIETY TEST OF FIELD PEAS, 1909.

NAME	Area in sq. ft.	Yield in lbs.	Yield in lbs. per acre	Yield in bu. per acre	Time of maturity
Golden Vine	2200	44	871.4	14.52	Aug. 28
San Luis	2200	....	....	....	Aug. 23
Green Canada	2200	42	831.6	13.86	Sept. 15
French June (19389)	2200	65	1287.0	21.45	Aug. 18
White Canada	2200	37	732.6	12.21	Aug. 21
White Marrowfat	2200	39	772.2	12.87	Aug. 28
Blue Prussian	3300	90.5	1195.0	19.91	Sept. 15
Potter (19788)	2200	32	633.6	10.56	Sept. 15
Black-eye Marrowfat	3300	54	712.8	11.88	Aug. 25
Canadian Beauty	2200	33	653.4	10.90	Aug. 28
Canadian Beauty	2200	27	534.6	8.91	Aug. 28

Potatoes.—The soil and climate of the Laramie valley seem to be particularly favorable to the growth of potatoes. In the testing of varieties the past year, observations were made upon the percentage of blight, on the percentage of rotted potatoes, and selections from a numbr of the varieties were made with a view of developing better yielding sorts.

From the crop of 1908 seed potatoes of the Six Weeks and Early Ohio varieties were selected and planted in comparison with field run potatoes. The following are the results:

Six weeks, field run seed........................242.4 bushels per acre
Six weeks, selected seed........................317 bushels per acre
Early Ohio, field run seed......................166.3 bushels per acre
Early Ohio, selected seed........................215 bushels per acre.

In each case it will be noted that a grain of 30% in yield was secured from the selected seed. Selections from both of these variaties were made for seed for next year.

CULTURE OF ROOT CROPS.

Root crops in the State of Wyoming have been but little grown up to the present time. The extensive system of ranching prevalent in the state has given little place to the culture of a crop that demands intensive methods. As more settlers come to the state, stock raising on a more intensive scale will need to be provided for. The former methods of ranching will give way increasingly to the practice of feeding stock

through the winter months. Stockmen are more and more emphasizing the value of a succulent food in providing for a healthy and continuous growth of stock through the winter. As corn is a minor crop in the state, silage will be little known, and hence, for the supply of a succulent food, root crops must needs be the most available source.

It is a notable face that nearly everyone who has ever grown roots for stock are ever after free in their praise of their value for this purpose. Quoting from R. S. Shaw in Bulletin 40 from Montana:

"The advantages derived from the use of field roots in feeding live stock are due rather to a secondary action than to the actual amount of nutriment supplied by them. During the winter season when dry foods only are available, they furnish a succulent adjunct which acts as a tonic, stimulating digestion, increasing the flow of milk and causing a great saving in the more expensive grain foods. Station tests here as well as elsewhere have proved that roots and grain form a more economical ration for pigs than grain only; that the increase in live weight is relatively greater, the cost of production less, and the quality of the meat of a higher grade. The comparative feeding values will be discussed in another publication."

Cultivation Experiments.—Free use of the weeder, harrow, and cultivator is made on all grain and cultivated crops. This practice is carried on in irrigated fields with a view of economizing irrigation water and also in the hope of growing better crops by the conserving of moisture and providing more favorable conditions for plant growth. This practice on the dry land is the foundation principle of conserving moisture and is absolutely necessary. Owing to the peculiar moisture conditions which prevailed during the late summer, when unusual rains came at just the time when crops growing under dry farming practices would be most benefited by moisture conserved through judicious cultivation practices,

the influence of the cultivation on crop yields is barely noticeable; neither is there shown a very marked increase in the amount of soil moisture where cultivation was practiced. The average percentage of moisture in the cultivated plots was always greater than on the uncultivated plots. This difference, while slight, was also immaterial on the irrigated land, but the cultivation of the cereals serves to destroy weeds and other foreign growth, and were it possible to have determined the exact amount of moisture necessary for maximum crops, it is evident that the cultivation practice would have resulted in the saving of irrigation water and the work of applying the same. The cultivation of crops on the dry land increased the moisture from 1.4 to 28.8% on the various plots; but as all of these crops were provided with sufficient moisture for healthy growth and normal yields through July and August rains, the cultivation practice did not seem to increase the product. The practice, however, is to be commended, and no doubt under other rainfall conditions, might show a very marked benefit in the yields.

Recognizing the truth of these statements, also the fact that a large portion of the new settlers of the state will not be informed regarding the methods of culture more successful under arid conditions, the plan is to determine by experiment the more successful methods of culture as regards the following points:

1. The relative value of fall and spring plowing.
2. The more successful varieties of each class.
3. The water requirements of root crops. (By Irrigation Eng.)

Root crops as used in this connection shall include beets, sugar beets, mangels, carrots, turnips, and rutabagas.

In connection with these experiments the following practices will prevail: Deep early plowing, thorough preparation of seed bed, a fertile soil, uniform seeding, a germination test of each lot of seed, good care throughout the period of

growth. Particular care needs to be exercised during the early life of the plants that they do not die from lack of moisture. Following the data secured from the experiments, there may be included a discussion of kinds of soil and their preparation, care of the crop, methods of harvesting and storing, and the keeping qualities of the various varieties.

In the season of 1908 there was an experiment carried on on Plot 3 at the Farm for testing the relative merit of fall and spring plowing for a grain crop. The south half of Plot 3 was irrigated and plowed in the fall of 1907, and the north half plowed in the spring of 1908. The whole area was then seeded to hulless barley.

On May 30th, when the barley was just up, nitrate of soda was applied to the south half of the fall plowed land and the south half of the spring plowed land, at the rate of 300 pounds per acre.

On July 18th the barley was just beginning to head. The nitrate plots presented a dark green color as compared with the lighter green of barley where no nitrate was applied. There was also some preference as to size in favor of the nitrate plots. On this date the whole plot was cut to the ground by a severe hailstorm. A thorough harrowing and irrigating were given the barley on the plot, and it revived and made an excellent growth in a few weeks.

On August 31st, just as the grain was in the milk, it was caught by a severe frost which necessitated cutting the whole plot for hay. The yields of hay for the various plots were found to be as follows:

On the fall plowed land, the nitrate of soda plot gave a yield of 4,918 pounds per acre; where there was no nitrate, a yield of 2,457 pounds per acre.

On the spring plowed land, the yield on the nitrate plot was 4,286 pounds per acre, and where no nitrate was applied, 1,944 pounds per acre.

GRASS INVESTIGATIONS.

In the spring of 1909 some investigations as to the relative maturity of the different species of grasses were undertaken. Plot No. 17 was devoted to this work. A backward spring and delay in securing proper soil conditions made the sowing of these grasses late. Continued dry weather for a period of three weeks after germination of the grass seed destroyed the majority of the plants and left a very unsuccessful stand. The list of grasses and the space allotted to each are given in the enclosed list. The best future treatment of this lot for securing a good stand seems somewhat uncertain. It may be necessary to plow the land and begin the work anew. The demand for more information as to the value of these different grasses seems to be an important consideration. The climatic conditions are again very favorable for work in this particular line. The Diamond ranch at Rock River has kindly co-operated in this work by furnishing areas for trial of several different kinds of grass.

On the south half of plots Nos. 14 and 15, several varieties of grasses were sown for the purpose of testing their resistance to alkali, the east end of No. 14 furnishing alkali in varying degrees. The grasses sown here were given a better opportunity than on the other plot, No. 17, and an excellent stand has been secured. While being a source of testing their alkali resistance, on plot 15 the same grasses may well be used to note the characters and value for hay purposes. The grasses sown on these two plots are as follows, beginning on the south side:

Sweet clover, 15 ft. space; brome grass 15 ft; tall meadow oat, 6 ft.; meadow fescue, 6 ft.; Italian rye, 6 ft.; perennial rye, 6 ft.; orchard grass, 6 ft. Besides the last named variety there were sown some saltbush and winter vetch. The remainder of the crop sown in this experiment were only annuals. This work has been under the direction of Professor Towar.

SOME EXPERIMENTS REGARDING THE CULTURE OF ALFALFA.

On plot 29 there was undertaken some comparative tests of methods best suited to securing a good stand of alfalfa, plot No. 30 being devoted to some experiments in the irrigation of young alfalfa. In the spring of 1909 plot No. 29 was divided into three equal parts, each 70 feet in width. The two plots to the south were plowed the latter part of March. The third plot on the north side was not plowed until 57 days later. These were fitted alike with planker and drag. Before seeding, the north half of each of the 70-foot plots was compacted by the use of the subsurface packer, and afterwards the whole acre was uniformly seeded. Throughout the entire season a strong preference was exhibited for the plots that had been treated with the subsurface packer, and also the plots that had been plowed early showed a very strong preference to the plot that was plowed only three days before sowing. This experiment may be classed as a demonstrative experiment to show the value of early preparation of a seed bed and the distinct advantage of compactness before the seed is sown. It will be an advantage to determine the results of these treatments in a comparative way during the coming season.

INVESTIGATIONS IN ROOT CROPS.

The state of Wyoming will be largely unadapted to the growth of crops for silage purposes, unless subsequent investigations along this line should make this feasible. As a succulent feed for winter feeding, where animal are to be given the best of care, root crops are destined to play an important part as a forage crop for the state. During the past two years the Station has attempted some work in the study of methods of culture most successful for roots. For the season of 1908 the conditions were such that no results

were possible. A comparative test of the various types and varieties was tried again in 1909. The ground on which they were sown was a sod plowed and sown to grain the year preceding, and used for this test the second year. A deep plowing and thorough preparation of the soil was given and the seed sown the latter part of May. It was the purpose to give these the best possible opportunity for a complete growth. They were given cultivation and care in every way beyond that which would be ordinarily furnished the crop in field practice. The season of 1909 was unusual in the amount of growing weather that was available. The results of the test would suggest that for carrots and mangels, the growing season is somewhat too short for a complete maturity. Rutabagas and turnips, especially the latter, reached a profitable production because of their adaptation to a shorter growing season. There is need of more work in this line, and the possible development of an earlier maturing mangel is worthy of trial. It is impossible to draw any definite conclusion at this altitude as to the best type or variety of root crop for the lower portions of the state. It will be difficult in the Laramie valley to solve this question of the culture of root crops in its adaptation to the whole state. This is also true of potatoes and sugar beets. The experience of the two seasons with sugar beets would especially indicate that they are not in any way a prospective crop for high altitudes, the growing season being considerably too short for their complete development. The areas of sugar beets sown, though given the best of care, did not yield a sufficient tonnage to make them profitable either for sugar or stock feeding purposes. More work will need to be done before they can in any way be recommended as a crop for the Laramie valley. The prospect seems not in the least encouraging to their success.

Fertilizer Experiments.—For three years preparations have been going on to establish a series of plots which might be used for soil tests with fertilizers.. This ground was sown uniformly, although not plotted, to spring rye in 1907. In 1908 the entire area was planted to potatoes and in 1909 to barley, with no special treatment applied to any of the plots. It was found rather difficult to find a series of uniform plots on land that has been leveled and ditched for irrigation. Another serious difficulty in connection with these plots was due to the ravages of the gophers. These animals ate off portions of the crop in the vicinity of their burrows and gave the crop a very patchy appearance. Therefore, the yields secured have not been of sufficient importance tó warrant their publication. These plots, however, were laid out in the spring of 1910, and a regular series of soil test experiments inaugurated, which will appear in the Agronomist's report.

From the results of previous experiments and from the study of the analyses of some of the soils of the Experiment Station farm, it is evident that nitrogen especially is needed. Accordingly, in 1908 plot No. 3, which has been cropped for a number of years, was used for a test of nitrate of soda as a fertilizer. Application was made at the rate of 300 lbs. of nitrate of soda per acre, which is a rather heavy application. Owing to the early severe frosts, the barley crop did not mature, and it was necessary to cut the entire crop for hay. The nitrate of soda increased the yield of hay by a little over 100%, and chemical analyses of the hay revealed the fact that the nitrate of soda increased the per cent of nitrogen over 16%.

In 1909 further tests were made on other plots of the experimental field. One of the tests was undertaken on a plot badly poisoned by alkali. The alkali, however, seemed to remain potent, and the results from the nitrate and ammonia applications were of no account. On another plot,

No. 9, sod was turned over in the spring and an application of 100 lbs. of nitrate of soda was made, and the crop employed was oats and barley. The following table gives the yields, which show conclusively the remarkable effects of nitrogen in this form as a crop producer:

	Area sq. ft.	Yield in lbs.	Yield in lbs. per acre	Yield in bu. per acre
Oats, Nitrate 100 lbs.	6000	262	1902	59.41
Oats, no Nitrate	6000	152	1103	34.5
Barley 87, Nitrate 100 lbs.	5200	208	1743	36.3
Barley, no Nitrate	5200	170	1424	29.7

Plot No. 20 is an area of ground that in the records of the Station has been devoted to grain production continuously for a period of at least twelve years. The productivity of this plot is very low, the soil seeming to be in a very depleted condition. There is no record of any manure or fertilizer having been applied to this plot. This last season the plot was divided into four quarter-acre areas. The quarter-acre on the north side was sown to field peas; the second quarter was maintained as a fallow strip; the third quarter was given to the oat crop and treated similarly to that in its previous history; the fourth quarter plot on the south side was treated with nitrate of soda at the rate of 100 lbs. per acre. The plan for the coming year was to note the effect of these various treatments on the succeeding grain crop to be sown this coming spring. The yields of oats for the plots on the south half for the season of 1909 are as follows:

	Area sq. ft.	Yield in lbs.	Yield in lbs. per acre	Yield in bu. per acre
Oats, no Nitrate	10.000	265	1154	36
Oats, Nitrate 100 lbs.	10,000	345	1503	47

PRELIMINARY TRIAL OF CROPS UNDER DRY FARMING METHODS.

During the spring and summer of 1908, Mr. Frank Holliday plowed about 160 acres of his homestead claim, one mile above this farm. Mr. Holliday kindly loaned the Station the use of twenty acres of this land in the spring of 1909. Various grain crops were sown on a four-acre area in strips 350 feet long. The area was given a disking the previous fall and also in the spring before sowing. The following crops were given a trial:

Emmer, sown at the rate of 30 lbs. per acre, gave a prospective crop, but was largely destroyed by gophers, making calculation as to yield impossible. Spring rye, sown at the rate of 30 lbs. per acre, yielded 6.4 bushels per acre. Durum wheat, sown 30 lbs. per acre, yielded 9 bushels per acre. Colorado No. 50, spring wheat, sown at the rate of 30 lbs. per acre, yielded 8.1 bushels. Field pease, sown at the rate of 45 lbs. per acre, yielded 7.2 bushels. About an acre of Strawberry potatoes were planted, which yielded at the rate of 91 bushels per acre. Kherson oats yielded at the rate of about 30 bushels per acre.

This preliminary test of the possibilities of dry farming was in no sense conclusive. The plowing, to begin with, was very poorly done, being at a depth of four or five inches. With some of the grains, the seeding was too thin for the best results. The Kherson oats and the potatoes were given, perhaps, the most satisfactory trial. Although the conditions were not entirely favorable to success with these crops, the results are very prospective for a profitable line of ininvestigation as to the possibilities of this work.

Report of the Agronomist

To the Director:

The writer took charge of the Department of Agronomy on March 1st, taking up the work left off by Prof. L. B. McWethy. On March 15th Mr. F. S. Puckett was appointed Foreman of the Agronomy Farm.

There is but little to be done in the way of making a report, as the general report of the year's work will come from Professor McWethy. As far as possible any important experiments begun by Professor McWethy and not completed by him will be continued this year. Some other lines of work will also be carried on. Among these are deep tillage experiments, moisture investigations, dry land cultivation experiments, etc. A thorough test of sugar beet growing will also be made, and an arboretum of over 150 shade and fruit trees has been planted. A weather station has also been added to the equipment of the Farm, so that a record of the maximum and minimum temperatures is being kept for each day; also the amount of precipitation. Experiments with commercial fertilizers will also be carried on more fully than in former years.

The work on the Farm is well in hand, and if weather conditions permit, there should be an abundant crop, furnishing a large amount of feed and grain, and it is hoped that there will be a large amount of seed for distribution among the farmers and ranchers of the surrounding country. There have been a great many calls for seed grain this spring, but very little was available. It is hoped that the Agronomy Department will do a good deal of pure seed work next year, especially with alfalfa and grasses.

The writer wishes to express his appreciation of the assistance received from Dr. J. D. Towar in getting started with the work this spring.

Respectfully submitted,

T. S. PARSONS, *Agronomist.*

Report of the Animal Husbandman

Work in the Animal Husbandry Department has been carried on largely along lines suggested in last year's report. There have been no changes in the personnel of the department staff, and this fact has aided materially in the progress made.

Experimental feeding with lambs and cattle has still further emphasized the value of Wyoming grains as compared with corn. Native hay and alfalfa have also been tested in lamb production. Results of this work appeared in bulletin form.

In pursuance with a policy adopted several years ago, Polled Herefords are being kept and bred with the idea of developing a good type of polled animal.

The co-operative sheep breeding experiment carried on with the Federal Department is being pushed along lines outlined by the Department. It is too early as yet to announce anything definite in the way of results.

During the past season quite extensive exhibits of sheep have been made by the University at the stock shows, held at the Alaska-Yukon Exposition, Chicago, and Ogden. Results in the shape of advertising and prizes won were most gratifying, the prize money more than paying all expenses incurred by the trips.

A new horse barn has been added to the Station equipment. In it is a stock-judging room, well lighted and provided with heating facilities. The barn itself is a commodious structure, offering an abundance of room both for horses and the storage of hay and grain. Minor improvements have been made in the sheep barns and both dwelling houses.

Very little additional stock has been purchased during the year. The dairy herd numbers two more Jersey cows, and several sheep have been added to the Station flock. Much

remains to be done in the way of building up the swine, dairy and beef cattle departments.

Plans for the future include a continuation of feeding investigations, with Wyoming grown crops; breeding work with both sheep and cattle; and investigational work under the Adams fund to determine the effect of feed on the total wool product of sheep. The coming fall will probably see the beginning of an experiment undertaken with the idea of ascertaining the value of down and long-wool blood in improving the quality of range sheep.

An attempt will be made to exhibit in the sheep classes at several of the leading live stock shows. Results during the past year have demonstrated conclusively the value of this method of bringing the work of the Station before the people of the West.

The Department will continue to do all in its power to intelligently serve the stock interests of the state.

A. D. FAVILLE.

Report of the Irrigation Engineer

LARAMIE, WYO., April 28, 1910.

DIRECTOR J. D. TOWAR, Laramie, Wyo.

DEAR SIR:—During the past fiscal year the work of the Irrigation Engineer consisted chiefly in carrying on the following lines of work:

AT LARAMIE.

Agronomy Farm.—Field B was subdivided into acre plots upon which root and grain crops were grown, and all subjected to irrigation experiments with reference to the proper quantities of water necessary to secure maximum yields, for which purpose the necessary records were entered to be used later in the final compilation of pertinent data.

In various other portions of the Farm some interesting and valuable experiments were conducted according to the same general scheme, relating to the growth of potatoes, alfalfa, etc.

Soil samples were also taken, of which the moisture determinations were derived by the Station Chemist.

The topographic survey was completed in the summer of 1909, and will soon be ready for mounting.

Stock Farm.—The co-operative alkali investigations carried on conjointly with the Department of Chemistry involved the measurements of the water-table fluctuations in tile-lined wells, the amount of water with which the alkalied tract was flooded and the quantity passing the underground tile drains.

The topographic survey (one of the most important items in the collaboration of the derived data) will be completed this summer, about one-half of the field work having already been finished.

AT CHEYENNE.

Numerous soil moisture samples were taken each Saturday during the crop growing season, and the same conveyed to the University of Wyoming for moisture determination, this work being carried on in co-operation with the Bureau of Irrigation Investigations.

RECOMMENDATIONS FOR 1910 AND 1911.

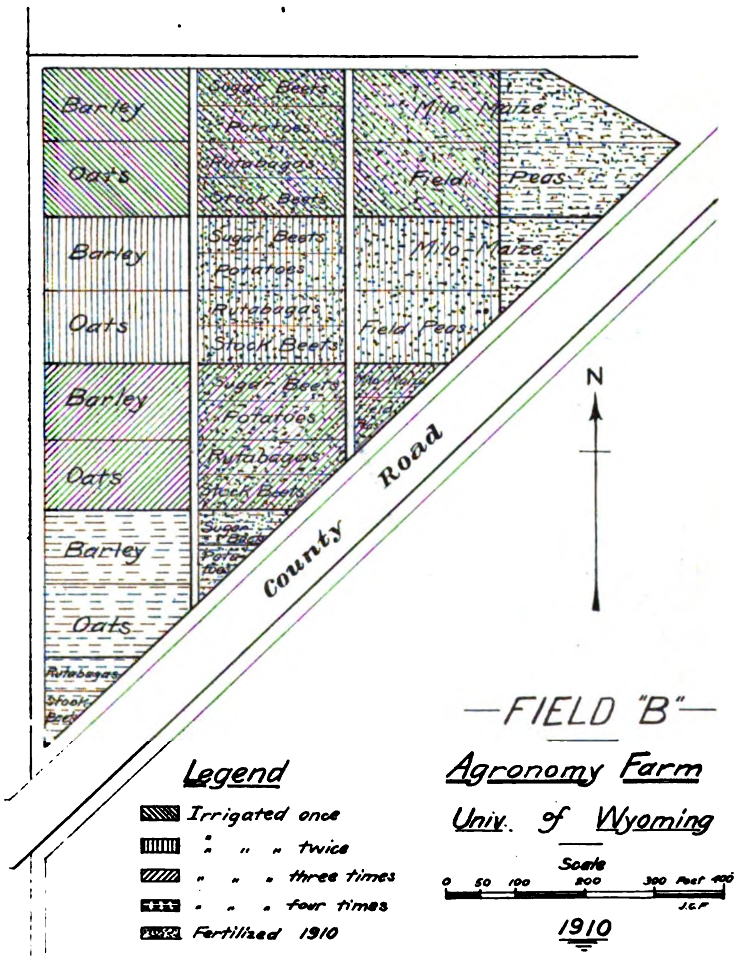
For the coming season, two new projects are respectively outlined and submitted, the results of which (if the projects are approved for execution) we believe will be of quite practical value to the ranchmen of our state, as well as many others.

The 1910 scheme for Field B (Agronomy Farm) is appended hereto, together with explanatory notations. The general conception being to try out, under the conditions imposed by a new season, the results heretofore obtained.

Because of the numerous measurements and detailed work required by the Station experiments, both on the Stock and Agronomy Farms, the services of a student assistant becomes almost a necessity. If such a person could be secured having careful, methodical habits of making measurements and recording notes, and having had a course in surveying besides, his help would be of great value in looking after the minor details of the various projects.

The soil moisture work on the Cheyenne Government Experiment Farm has been rather of negative value to the Wyoming Experiment Station as far as practical and useful results are concerned. Due to their great erratic variation these determinations apparently fail to establish any new truth or place any well known law in a new light.

J. C. FITTERER.


Barley
Oats
Sugar Beets
Potatoes
Rutabagas
Stock Beets
Milo-Maize
Field Peas
Barley
Oats
Sugar Beets
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Stock Beets
Milo-Maize
Field Peas
Barley
Oats
Sugar Beets
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Stock Beets
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—FIELD "B"—
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Irrigated once
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Scale
0 50 100 200 300 Feet 400
J.C.F
1910

Report of the Chemists

At the beginning of the year plans were made by which the help in the Department was materially increased, and a new laboratory was provided for research under the Adams act. In September, Dr. L. Chas. Raiford came to us and took up work under the Adams act and Mr. Hill was given the position as assistant, so that the work along projects outlined under the Adams act has been progressing quite satisfactorily. Most of the time of Dr. Raiford has been taken up, during the past year, with the alkali problem upon samples which had been collected during the years 1908 and 1909.

The wool investigations which have been outlined have been in progress, but results in this field of investigation come very slowly. It is intended that more time will be devoted to wool investigations during the coming year than during the past.

Of the projects outlined under the Hatch act only two have been worked upon during this year. Forage plant investigations have been continued and a bulletin will be ready for the press before the end of the year. The digestion investigations which were outlined have not been carried on this year because of unsurmountable difficulties.

The effect of soil constituents upon the composition of plants will be taken up during the summer when plants may be collected along with the soils.

No plans are being made to enlarge the Department the coming year so we would advise that the same appropriations be made from the Hatch fund and Adams fund as during the past year.

The work outlined for the past year was as follows:

Adams Act—

1. Soil moisture investigations.
2. Alkali investigations.
3. Wool investigations.
4. Investigations of poison in one or two of our Wyoming plants.

Hatch Act—

1. Digestion investigations.
2. Forage plant investigations.
3. Effect of soil constituents upon the composition of plants.
4. Alkali investigations.

The soil moisture investigations outlined under the Adams act have been carried on in co-operation with the Irrigation Engineer during the past year. The soils were collected by the Irrigation Engineer and the moisture determinations were made in this laboratory. The results have been turned over to the Irrigation Engineer.

The alkali investigations have been carried on in conjunction with the drainage work at the Stock Farm of the University of Wyoming. This land is practically reclaimed and this phase of the work will necessarily close.

The wool investigations have been carried on continuously throughout the year, although only a small portion of the time of Dr. Raiford has been devoted to this work.

The investigations of the poisons present in our Wyoming plants have not developed to such a stage that the chemists can take hold of the problem. It is probable that during the coming season, material will be collected and enough investigations will be carried on by the Veterinarian, that the problem can be attacked by the Chemists.

Plans were laid for starting digestion investigations in the fall but, for various reasons, the work was never begun. It is hoped to continue this work during the coming year.

Forage plant investigations have been pushed during the past year and the results of the year's work will soon be ready for publication.

Nothing has been done upon the effect of soil constituents upon the composition of plants. This will be taken up during the coming season. Samples of soil will be collected at the time the plants are growing, consequently collections must be made during the growing season.

PLANS FOR FUTURE WORK.

Adams Act—

1. Soil moisture investigations. (In co-operation with the Irrigation Engineer.)
2. Alkali investigations.
3. Wool investigations. (A portion of this work to be carried on in co-operation with the Wool Expert.)
4. Investigation of the poisons present in the woody aster. (A portion of this work is to be taken up in co-operation with the Veterinarian.)

Hatch Act—

1. Digestion investigations. (In co-operation with the Animal Husbandman.)
2. Forage plant investigations. (In co-operation with the Botanist.)
3. The effect of soil constituents upon the composition of plants. (In co-operation with the Agronomist.)
4. Alkali investigations.
5. The cause of certain lands being "spotted."
6. Relation of organic matter to bacterial activity in soils.

Signed, HENRY G. KNIGHT.

LARAMIE, WYO., May 13, 1910.

Report of the Wool Specialist

J. A. HILL.

The Wool Department during the past year carried on the work begun in former years, and started one new experiment. This new experiment is being undertaken for the purpose of studying the effect of environment upon the quantity and quality of wool which a sheep will produce. Ten sheep are being kept on a farm in Ohio, and a like number on the range in Wyoming. After two years the Wyoming sheep will be sent to Ohio and the Ohio sheep to Wyoming and run for two years longer. A study will be made of all the wool produced by these twenty sheep in the entire four-year period, the wool from Wyoming being compared with that from Ohio in every possible way. This method of procedure, not only should determine the exact difference of the wool from these two states, but should also give some clue to what causes the difference, whether it be difference of climate, soil, water, food, or care. Any such clue could then be followed up and a thorough understanding obtained concerning the effect of environment upon wool production.

Ohio was selected as the state outside of Wyoming in which to begin the experiment, because Ohio wool is considered to be the best produced in the United States. Later on the scope of the experiment may be widened until sheep are interchanged between Wyoming and many other localities in America and even foreign countries.

The sheep being kept in Ohio are purebred wethers and were one year old in the spring of 1910. The following breeds are represented by two sheep each: Rambouillet, Delaine, Shropshire, Dorset, and Cotswold.

It was planned to have the same breeds and ages for running on the Wyoming range, but it was impossible to obtain the breeds desired. So a flock of crossbreds has been secured, containing blood of the following breeds: Shropshire, Hamp-

shire, Oxford, Dorset, Rambouillet, Lincoln, and Cotswold.

Since the experiment is for the purpose of studying the effect of environment on wool rather than on breeds, these sheep of mixed breeding will fulfill all the requirements.

The time of the Department during the past year has in the main been taken up by the study of variability in the breaking strain of wool fibers. A detailed report of this work in the form of a technical bulletin is almost completed. The work done has proved conclusively that, for any accurate comparison of the average breaking strain of two or more samples of wool, it is necessary to test the breaking strain of a large number of fibers—reaching into the thousands—from each sample, as the mean of a few hundred tests is likely to be far from the true mean of the sample from which they are drawn.

During the summer of 1909, twenty-one firms sent in a total of 4,318 pounds of wool for the purpose of having the shrinkage tested. This is a very slight gain both in number of firms and quantity sent over the preceding year, in which 2,746 pounds were sent in by seventeen firms.

As has been done in the past three years, a circular letter was sent in April to the sheep owners of the state, offering to test and report the shrinkage of a sample bag of their wool free of charge. The sheepmen are seemingly taking less interest in this offer this year than ever before. Because of this lack of interest on the part of those for whose benefit it was made, I recommend that it be not made another year, and that the scouring plant be used only in the experimental problems of the Station.

The equipment of the Department has been made better by the addition of a high class microscope and a second fiber testing machine. The force of the Department has been increased by the addition of Mr. C. J. Oviatt, Assistant Wool Specialist, who entered upon his duties in October.

TABLE SHOWING RESULTS OF SHRINKAGE TESTS ON WOOL FOR 1909.

NAME OF OWNER	ADDRESS	No. of Fleeces	GRADE	Wt. lbs. Raw	Wt. lbs. Scoured	Per cent shrinkage
Wm. Daley Co.	Rawlins	General sample	Ewe, Fine med.	6½	2¼	65.4
Wm. Daley Co.	Rawlins	" "	Lamb, Fine med.	6½	2	69.2
Willow Glen Sheep Co.	Greub	14	¼ blood	173	90	48.0
Pioneer Sheep Co.	Baggs	57	Medium	258	119	58.2
F. S. King Bros. Co.	Laramie	General sample	Fine med.	4⅜	1½	65.7
G. W. Waisner	Sheridan	23	Fine to Med.	324½	116	64.2
Carbon County S. & C. Co.	Rawlins	General sample	Fine med.	1⅛	⅜	62.9
Carbon County S. & C. Co.	Rawlins	" "	Fine med.	1½	⅝	59.2
Beckwith, Quinn & Co.	Sage	" "	Fine med.	8⅞	3¼	63.6
Beckwith, Quinn & Co.	Sage	" "	Fine med.	6	2⅛	65.3
Beckwith, Quinn & Co.	Sage	" "	Fine	9¼	2	79.1
Otto Gramm	Laramie	" "	Fine med.	6⅞	2⅜	65.5
H. L. Stevens	Laramie	1	Fine med.	11	3	72.7
J. D. Watson	Ft. Bridger	12	Fine med.	87½	25½	70.9
J. D. Watson	Ft. Bridger	10	⅜ blood	84½	40	52.7
J. D. Watson	Ft. Bridger	18	Medium	125½	44½	64.5
C. & H. Bayer	Casper	29	Ewe, Fine med.	306	90	70.6
C. & H. Bayer	Casper	10	Lamb, Fine med.	76	24½	67.8
Q. S. Douglas	Newcastle	44	Fine med.	352½	114	67.7
Salmon Bros. & Fenner	Kemmerer	32	⅜ and ¼ blood	262	109½	58.2
L. R. Ennis	Alzada, Mont.	34	Med. and ⅜ blood	256	114½	55.1
J. M. Cattle Co.	Jayem	57	Fine med.	382½	137	64.2
Clarence Taffner	Alzada, Mont.	35	Med and ⅜ blood	283½	118	58.4
Clarence Taffner	Alzada, Mont.	5	⅜ blood	49	22½	54.1
R. L. George	Laramie	8	Med. and ⅜ blood	74½	34	54.4
R. L. George	Laramie	11	Fine med.	158½	62	60.9
T. D. Dempsey	Thermopolis	7	Fine med.	56	21	62.5
T. D. Dempsey	Thermopolis	94	Spring lamb	226½	114	49.7
K. McDonald	Wolton	6	Yearling, Fine med.	52½	21½	59.1
K. McDonald	Wolton	9	Med. and ⅜ blood	69	32	53.6
K. McDonald	Wolton	21	Fine med.	197	68½	65.2
A. H. Senff	Kemmerer	44	¼ blood and below	346	195	43.6
U. S. Bureau An. Ind.		4	Fine med.	56½	17½	69.0

Report of Botanist

AVEN NELSON.

The work of the Botanist during the year has been largely of a routine character in so far as it pertains to the Station. So much of his time is taken up with teaching and with office work in several lines (not to mention field and herbarium work in systematic botany) that no time remains for real research, nor even experimental work. Every experiment station necessarily has a considerable correspondence pertaining to botanical matters. This correspondence naturally reaches this office and it receives the best attention of which the writer is capable and which the facilities of the office can supply.

What is true of botanical matters is equally true of horticulture and entomology. Since these departments are not represented on the Station staff it has been the pleasure of the writer to sustain to these fields also a "consultation" relation. The inquiries in each of these greatly adds to the office work and the correspondence. This is particularly true in horticulture, since it happens that the writer is also the Secretary of the State Board of Horticulture and the "Inspector in Chief" for said board, as well as the Secretary-Treasurer of the State Horticultural Society. It will readily be seen that by reason of this combination of circumstances most of the official horticultural work of the state is thrown into this one office.

The Botanist continues to co-operate with other departments as follows:

1. Field work in the Department of Chemistry, assisting in the collection and determination of the native forage plants for analysis. A week was spent in this way last season.

2. The preparation of the popular and technical descriptions of the forage plants represented in the series of bulletins giving the results of the chemical analyses.

3. Field work upon poisonous plants. This has led up to the theory that the Woody Aster (*Xylorrhiza*), or the fungus upon it, is responsible for the severe sheep losses in certain areas of the state (See press bulletin No. 10, "A Plant Under Suspicion"). Research work is now under way by the staff of the Veterinary Department to prove or disprove the theory. It may also be mentioned that the Department of Chemistry is now at work upon one of the species of Camass (*Zygadenus intermedius*) which the writer thinks is responsible for many of the sheep losses in the foothill and mountain country.

4. The University grounds are being used as a trial grounds for both woody and herbaceous ornamentals. Gradually the very meager list of those that are available for high altitudes is being increased. Some day it may be advisable to issue, for the help and guidance of others, a list of those things that are proving peculiarly well suited to our conditions.

5. Under the direction of the Agronomist, some experiments in tree and fruit growing that promise to be of great interest and possibly of much value, have been undertaken on the Experiment Farm. These experiments include a variety of shade and ornamental trees and a very considerable list of the new things introduced or originated by Prof. Hanson of the South Dakota Station. Some portions of Wyoming are very similar to the Dakotas, and we ought to profit through the marked achievement of Hanson. While the responsibility for these experiments has been very kindly taken over by Professor Parsons, the writer is keeping in interested touch with them all.

A small portion of the writer's time has been given to assisting in farmers' institute work and to writing for the Station and other publications.

Report of the Veterinarian

May 25, 1910.

To the Director.

I herewith submit a brief report of my work as Station Veterinarian for the year ending June 1, 1910. The year's practical work in caring for the Station stock embodies the treatment of some 64 independent cases. Each case taken would generally average at least two calls per case, making a total of some 125 calls to one or the other farm during this period. Individual reports were made to the Director of all cases of importance; hence, there is no need to give a detailed statement of the cases treated.

One loss was of great importance, that of the black mare purchased at the Denver Live Stock Show. The death of this animal was due to enteritis following a long continued laxative condition of the bowels as a result of colic. All cattle capable of being handled have undergone the annual tuberculin test with the result that two reactors were found, one being the Holstein-Friesian purchased at Denver last year, the other the dark Jersey heifer. Precautionary measures concerning their keep have already been suggested.

APPROPRIATIONS FOR THE COMING YEAR.

AGRICULTURAL.

Medical agents	$ 75.00
Instruments and one instrument case	350.00
Total	$425.00

RESEARCH.

The plans for Adams fund work are already known to the Director, and it is only necessary to say that this work has already been begun; that two assistants are now in the field, and everything is apparently in readiness to meet with all conditions that may arise in this work during the season.

All research work in this Department is identified very closely with bacteriological and pathological processes, and consequently, inasmuch as we lack equipment in these lines, the work is greatly handicapped and checked.

RESEARCH APPROPRIATION.

Hatch Fund.—Sufficient funds for this preliminary work are on hand.

Adams Fund.	Salary assistant, at $75 per month	$300.00
	Expense while in the field	100.00
	Railroad fare	50.00
	Purchase of experimental animals (laboratory and field)	50.00
	Purchase of laboratory supplies, culture media, extras, etc.	50.00
	Total	$550.00

RECOMMENDATIONS.

It is thought advisable to recommend that a certain portion of the farmers' institute fund be set aside for this Department to cover the purchase of lantern slides and pathological specimens of benefit in giving the work in this line required of the Department. Up to the present time the University and Experiment Station have purchased no instruments with which to carry on the practical work and classroom work, the instruments in use being the personal property of the Veterinarian. These have been necessarily disposed of, and it is recommended that the appropriation asked for be given. A list of the instruments to be purchased by this appropriation are submitted with this report.

MISCELLANEOUS.

The irregular work of the Department includes correspondence relative to this branch of work, institute work, cooperation with the State Veterinarian's office and with the various other stock boards when they may so desire, a start in a new field, which is co-operative with the Pure Food Commission, and a certain amount of laboratory diagnostic work for various of the city physicians.

Respectfully submitted,

O. L. PRIEN.

Meteorological Summary for the Year 1909

JANUARY 1ST TO DECEMBER 31ST.

The weather conditions for the year were generally normal or nearly so, there being no remarkable disturbances. storms nor wind conditions. Unfortunately, the anemometer went wrong early in the summer and it was several months before the difficulty was discovered and the instrument properly repaired. So unreliable and incomplete were the wind records for the year that the report is considered not worth printing. Through an omission, due to change of the student assistants who took the observations, the records of ground thermometers for four months are incomplete or entirely lacking.

The average temperature for the year was about normal. The average for the growing season, June to November, is high in comparison with former years. April and December were especially cold, while January and November were several degrees warmer than the average. There was no frost between May 25 and September 22, giving a season of *no frost* longer than usual. Temperature records have been kept for 19 years. This year three records were broken—it was the warmest January and the coldest April and December in the history of the Laramie weather conditions.

Precipitation for the year was of nearly normal distribution, there being an excess in August and a shortage in the early part of the season. Total for the year was slightly below the average.

The per cent of sunshine was below the average and the records show a falling off in the number of clear days. So far as the wind records were kept there was nothing abnormal.

EXPLANATION OF THE FOLLOWING TABLES.

The *terrestrial minimum* shows the lowest temperature at the ground, and may register a frost which will kill some

vegitation, while the official record, taken six feet above, will indicate no frost.

The *dew point* is the temperature to which the air has to be reduced in order to precipitate the moisture.

The *vapor pressure* is the relative amount of water in the air, and depends upon the temperature.

The *solar radiation* is the effect the sun's rays have upon the surroundings, and is expressed in degrees.

In the table of precipitation T stands for *trace,* or less than .01 of precipitation.

Snowfall is measured with a yard stick in several places and the average taken. Ten per cent of snow is considered water.

A. E. BELLIS,
Observer.

TEMPERATURE MEANS FOR 19 YEARS.

YEARS	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	High-est	Low-est
1891	20.2	23.3	25.6	40.5	54.5	58.4	61.2	61.1	55.1	43.2	28.6	19.6	40.9	83	—18
1892	20.6	25.2	30.8	35.5	44.4	55.7	62.8	61.9	56.0	39.2	33.1	20.7	43.8	85	—29
1893	26.8	20.7	28.8	34.2	44.2	57.2	64.0	60.7	52.8	42.3	29.2	26.6	40.6	87	— 9
1894	19.9	16.2	29.4	39.1	52.3	55.8	63.2	62.2	51.8	44.4	22.8	21.5	39.9	88	—27
1895	20.5	17.9	27.5	40.0	45.3	52.2	58.8	61.6	54.5	40.9	27.0	15.3	38.5	87	—30
1896	27.7	22.8	26.2	37.4	47.3	59.1	62.3	61.9	52.6	41.9	26.8	31.4	41.4	84	—27
1897	16.5	21.2	24.3	35.0	49.3	58.9	60.7	60.5	56.8	42.3	34.8	15.0	39.6	85	—30
1898	17.0	25.5	26.8	40.3	44.1	56.8	65.1	62.9	51.9	39.3	23.1	14.3	38.9	88	—28
1899	20.6	9.5	24.5	38.3	45.5	55.8	62.1	67.0	59.7	40.8	35.7	17.2	39.7	87	—40
1900	25.7	19.7	32.2	35.9	50.8	61.5	62.8	62.3	51.8	45.1	38.5	25.7	42.7	91	—27
1901	19.3	19.4	26.5	34.5	49.5	53.6	67.8	62.7	52.4	44.4	31.8	20.9	40.2	92	—28
1902	22.2	26.2	27.5	37.6	49.0	58.0	59.9	57.4	51.5	44.3	32.6	24.5	40.9	91	—18
1903	23.3	11.5	29.3	37.5	43.9	53.9	62.7	63.1	51.2	43.8	34.8	26.4	40.1	84	— 8
1904	20.2	29.7	32.5	38.5	46.8	54.0	60.5	61.5	54.3	42.2	35.5	26.2	41.8	84	—16
1905	23.1	15.5	34.6	35.6	44.6	58.3	61.4	62.9	54.9	37.4	33.0	22.2	40.3	91	—42
1906	24.5	27.5	24.7	39.8	47.4	55.1	60.3	61.6	53.7	40.3	29.1	30.0	41.1	88	—19
1907	24.7	32.9	36.1	37.1	42.2	53.5	62.6	61.5	53.7	44.7	30.1	23.5	41.9	85	— 9
1908	19.75	24.5	33.8	41.8	44.6	54.4	61.4	60.3	54.9	39.5	25.5	23.8	40.3	86	—24
1909	28.1	23.5	28.7	32.5	43.2	57.2	65	64	53	45	36	13.62	40.8	90	—28
Sum	420.7	412.7	549.8	711.1	888.9	1069.4	1184.6	1177.1	1022.6	800.5	587.5	417.92	778.4		
Means	22.1	21.7	28.9	37.4	46.8	56.3	62.3	61.9	53.8	42.1	30.9	22.0	40.7		

GROUND THERMOMETERS FOR 1906-07, 1908 and 1909.

	Average for 1906 and 1907						1908						1909					
	6 in.	12 in.	18 in.	24 in.	36 in.	72 in.	3 in.	6 in.	12 in.	24 in.	36 in.	72 in.	3 in.	6 in.	12 in.	24 in.	36 in.	72 in.
January	27.1	26.9	26.5	28.9	30.1	37.8	26.2	25.5	26.1	28.5	31.8	38.7	29.9	30.0	30.8	31.6	33.8	38.7
February	31.3	29.8	29.2	30.	31.3	36.5	30.4	28.3	27.4	28.8	31.0	36.5	29.4	28.7	29.0	30.1	32.3	37.7
March	35.8	34.6	32.9	32.7	33.2	36.4	41.6	39.8	35.8	34.1	35.1	36.8	35.9	34.2	32.5	31.9	32.9	37.0
April	47.9	46.3	43.	41.	39.8	39.1	50.9	49.8	45.3	43.0	41.7	40.7		Records incomplete				
May	53.6	51.8	47.3	46.2	44.7	42.8	52.0	50.8	48.0	45.8	44.6	48.3		"		"		
June	66.3	63.8	58.2	55.2	52.5	47.4	64.3	64.6	59.5	55.0	52.3	45.5		"		"		
July	72.9	70.9	66.	62.2	59.	52.9	72.6	71.5	66.2	62.6	59.7	53.6		"		"		
August	73.8	71.2	66.6	63.3	61.5	56.	69.8	69.7	65.3	62.3	60.5	62.7	73.9	72.8	69.4	65.8	63.3	57.8
September	63.8	61.4	59.2	58.7	57.8	56.2	66.2	44.4	61.4	49.9	58.8	55.9	64.7	63.5	60.5	59.4	58.4	57.0
October	49.6	49.7	48.5	49.8	50.6	52.6	46.1	46.6	46.1	48.2	49.6	52.9	51.2	50.5	49.3	50.8	51.5	53.7
November	35.2	36.3	36.7	39.4	41.	45.6	33.2	36.2	32.2	38.7	70.5	46.8	38.0	37.9	38.4	41.5	43.5	49.0
December	29.	29.8	30.6	33.6	35.7	42.5	24.6	27.4	28.4	31.1	34.7	41.9	21.8	23.1	25.3	30.3	34.6	43.5
Sum	586.4	572.5	544.7	541.0	537.2	545.8	577.9	554.1	541.7	528.0	570.3	555.3						
Average	48.8	47.7	45.4	45.0	44.8	45.5	48.2	46.2	45.1	44.0	47.5	46.2						
	46.2						46.2											

PRECIPITATION FOR 19 YEARS.

YEARS	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1891	0.70	0.38	1.50	0.25	2.92	0.91	1.20	1.76	1.80	0.30	1.09	1.11	13.92
1892	0.01	0.36	0.52	0.19	1.16	3.97	2.22	0.14	T	3.96	T	0.20	12.73
1893	T	0.11	0.20	0.32	0.33	0.54	0.34	1.08	0.39	0.28	0.06	0.10	3.84
1894	0.03	0.10	0.29	1.51	0.42	0.64	1.41	1.26	1.60	0.09	0.05	0.23	7.63
1895	0.06	0.14	0.43	0.87	2.09	2.12	2.71	1.17	0.18	0.74	0.32	0.33	11.15
1896	0.44	0.17	0.59	3.53	2.37	1.72	1.66	0.89	1.16	0.18	0.09	T	12.80
1897	0.39	0.35	4.23	0.55	1.85	0.72	1.29	1.11	0.32	0.55	0.33	0.77	12.48
1898	0.05	0.01	0.40	1.26	1.88	0.90	0.65	1.16	T	0.48	0.61	0.23	7.63
1899	0.95	1.13	1.11	1.75	0.37	1.11	2.01	1.43	0.17	1.13	0.07	0.61	11.84
1900	0.01	0.82	0.58	2.91	0.24	0.35	1.25	0.61	1.11	0.56	0.06	0.03	8.53
1901	0.04	0.41	0.05	0.28	3.00	1.73	0.32	1.11	0.09	1.28	T	0.21	8.52
1902	T	0.26	0.41	0.88	0.26	0.60	1.49	0.40	1.58	0.74	0.22	0.89	7.72
1903	0.11	0.36	1.09	0.73	1.63	1.00	1.31	0.88	2.37	0.54	0.30	0.07	10.37
1904	0.25	0.11	0.36	0.84	1.74	2.01	1.33	0.93	1.35	0.50	0.04	0.08	9.53
1905	0.39	0.42	0.64	1.21	1.79	0.36	1.79	0.83	1.62	0.46	0.22	0.03	9.76
1906	0.58	0.05	1.01	1.75	0.91	1.71	1.75	0.59	2.09	1.33	0.41	0.39	12.57
1907	0.29	0.15	0.28	0.78	1.09	0.90	3.68	1.28	0.62	0.16	T	0.23	9.46
1908	0.24	0.08	0.02	0.34	5.57	0.84	2.68	1.93	0.65	0.45	0.38	0.35	13.53
1909	.34	.27	1.11	.76	1.66	.67	1.00	1.87	.97	.50	.29	.24	9.68
Sum	4.90	5.68	14.91	20.71	31.28	22.80	30.09	20.43	18.09	14.23	4.54	6.10	193.75
Means	.26	.30	.78	1.09	1.65	1.20	1.58	1.08	.95	.75	.24	.32	10.19

SUMMARY BY MONTHS FOR 1909.

MONTHS	Temperature								Precipitation			Days			Average Dew Point	Average Relative Humidity	Average Vapor Pressure	Per Cent of Sunshine	Snowfall Inches	Average Solar Radiation	Barometer Average
	Maximum	Date	Minimum	Date	Means	Av. Terrestrial Min.	Mean Max	Mean Min.	Total	Greatest in 24 hours	Date	Clear	Partly Cloudy	Cloudy							
January	49	19–20	—16	11	2.8	12.8	39.6	16.6	.34	.12	22-23	17	11	3	17.1	67.2	.0986	72.5	3.6	79.6	23.313
February	56	2	—11	9	23.5	11.	35.8	11.2	.27	.21	14	18	4	6	13.0	67.6	.0770	73.0	3.1	80.0	22.904
March	55	3	— 4	8-12	28.7	15.3	40.4	17.1	1.11	.56	28	19	8	4	17.0	70.1	.0952	70.3	11.3	87.9	22.915
April	69	17	4	6– 8	32.5	20.6	44.6	20.5	.76	.27	20	18	9	3	22.0	75.8	.116	72.0	7.5	....	22.966
May	68	27	12	1	43.2	31.3	56.2	30.2	1.66	.93	24	19	4	8	33.0	69.3	.185	66.7	3.0	101.4	22.980
June	86	28	35	1	57.2	44.1	71.6	42.8	.67	.30	19	24	5	1	43.0	62.1	.283	83.3	.....	117.0	22.843
July	90	17	42	8	65.	46.5	81.	49.	1.00	.40	5	21	4	6	47.0	54.8	.325	79.0	.....	130.0	23.162
August	88	15	39	3	64.	44.2	79.	49.	1.87	.73	17	.....	.....	....	47.0	63.9	.342	61.8	.....	125.0	23.209
September ...	79	3	23	22	53.	35.9	68	39	.97	.32	5	14	14	2	38.0	62.3	.238	71.7	.....	125.0	22.846
October	75	3	15	9-12	45.	26.4	61.	29.	.50	.16	6	15	16	....	25.0	53.8	.140	75.2	.90	127.0	23.125
November ...	67	3	2	16	36.	21.8	48.	24.	.29	.17	20	8	12	10	21.0	66.1	.121	50.0	.60	127.0	23.022
December	46	31	—23	18	13.62	4.6	25.9	13.5	.25	.10	6	10	11	10	7.8	75.2	.066	58.0	2.5	127.0	22.940
Sum	828		118		464.5	314.5	651.1	341.9	9.69	....	......	183	98	53	330.9	788.2	2.0868	833.5	32.5	1226.9	275.725
Average	69		9.8		38.7	26.2	54.2	28.4	9.69	.93	......	183	98	53	27.5	65.6	.174	69.4	2.7	111.5	22.977